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ABSTRACT

The Science Subcommittee began its oversight of the implementation of the High-Performance Computing Act of 1991 by focusing on the establishment of the National Research and Education Network (NREN), which will evolve out of the current internet, the National Science Foundation's (NSF) NSFNET. The policy issues under discussion were: providing a level playing field for network services providers; ensuring that the network is responsive to user needs; providing for effective network management; determining the level of consultation that has occurred between the NSF, the network user, and provider communities during the course of developing the policies for governance and operation of the NSFNET backbone; and moving toward the long-term vision for the NREN, including the appropriate roles of the public and private sectors. Included in the hearing report are statements from Bob Traxler and Jerry F. Costello of the House Subcommittee on Science and testimony from the following witnesses: Eric Hood, Federation of American Research Networks and Northwestnet, Inc.; Douglas E. Van Houweling, Merit Network, Inc. and the University of Michigan, Ann Arbor; Mitchell Kapor, Commercial Internet Exchange Association and Electronic Frontier Foundation; Michael M. Roberts, Educom; William L. Schrader, Performance Systems International, Inc. Also included are a statement by A. Nico Habermann and Stephen S. Wolff, National Science Foundation; the Subcommittee and Full Committee markups of H.R. 5344, Amendment to the NSF Act of 1950; and an additional statement submitted for the record by E. Michael Staman, CICNet. (ALF)

IR.

MANAGEMENT OF NSFNET

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HEARING
BEFORE THE
SUBCOMMITTEE ON SCIENCE
OF THE
COMMITTEE ON
SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
ONE HUNDRED SECOND CONGRESS
SECOND SESSION

MARCH 12, 1992

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MANAGEMENT OF NSFNET

THURSDAY, MARCH 12, 1992

House of Representatives,
Committee on Science, Space, and Technology,
Subcommittee on Science,
Washington, D.C.

The subcommittee met, pursuant to call, at 10:06 p.m., in room 2325, Rayburn House Office Building, Hon. Rick Boucher [chairman of the subcommittee] presiding.

Mr. Boucher. The subcommittee will come to order.

This morning, the Science Subcommittee begins its oversight of implementation of the High-Performance Computing Act of 1991, which was signed into law last December.

The initial focus of the subcommittee and the subject of this morning's hearing will be the establishment of the National Research and Education Network, commonly referred to as the NREN. It will be a high-speed network that will provide broad access to the research and education communities and lead to a privatized infrastructure serving the needs of all sectors of society.

It is essential as the network is structured that all commercial providers of network services receive equal treatment and that Government policy in managing the network not favor any provider or set of providers over others. Adequate attention and support must also be given to stimulating the advancement of network technologies and to developing standards that will allow a seamless, user-friendly national network to emerge.

The NREN will evolve as an outgrowth of the current internet. A major component of the internet is the NSFNET, which is supported by the National Science Foundation for research and for education purposes. Policy decisions regarding the operation of the NSFNET reverberate among the network user and provider communities. This effect is evident in the aftermath of the decision to allow the mixing of research and education traffic with commercial traffic on the NSFNET backbone. Today the subcommittee will review the administration and the operation of the NSFNET since current practices will strongly influence the evolution of the NREN.

We have asked our witnesses to focus on the agreement that has been put in place by the National Science Foundation for the operation of the NSFNET backbone as well as on the Foundation's plan for recompetition of the current agreement. We will explore whether the NSF's policies provide a level playing field for network service providers, ensure that the network is responsive to user needs, and provide for effective network management.

We are also interested in determining the level of consultation that has occurred and is occurring between the NSF and the network user and provider communities during the course of developing the policies for governance and operation of the NSFNET backbone.

Finally, we have asked today's witnesses to provide their thoughts on the best strategy for moving toward the long-term vision for the NREN, including the appropriate roles of the public and private sectors. Ultimately, success in establishing the NREN will require a collaborative undertaking among Government, network providers, and the broad network user community. In this and in future hearings, it will be the intention of this subcommittee to help foster that collaborative relationship.

I would like to extend a welcome to this morning's witnesses. Before turning to our witnesses, the chair will now recognized the ranking Republican member of the subcommittee, the gentleman from California, Mr. Packard.

Mr. **Packard**. Thank you very much, Mr. Chairman.

I want to take this opportunity to commend you for calling this hearing. You have responded very quickly to the concerns that have been raised over the management of NSFNET. The chairman and I both have a strong desire to air these concerns and to determine what course of action, if any, will be needed to ensure that NSF is properly managing this network.

The NSFNET is critical to the future of the National Research and Education Network, better known as NREN, which is a key component of the high-performance computing program. It is important that in the eventual evolution from the current network to the NREN we ensure that there is equal access for network users and that all the commercial providers of network services are treated fairly.

I'm sure that this hearing will give us useful insight and guidance in planning for the implementation of the High-Performance Computing Act. I welcome all of you who are here as witnesses and look forward to your testimony today and trust that it will lead to a very helpful conclusion, and thank you very much, Mr. Chairman, for calling the hearing.

[The prepared statements of Messrs. Traxler and Costello follow:]

statement of

HONORABLE BOB TRAXLER

HOUSE SCIENCE, SPACE AND TECHNOLOGY COMMITTEE

SUBCOMMITTEE ON SCIENCE

MARCH 12, 1992

Thank you very much, Mr. Chairman, for the opportunity to appear before your Subcommittee today. This hearing is an important step in the process of our fully understanding and appreciating the various factors that should be considered as we chart the future of computer networking in this country.

I appear before you today as Chairman of the VA-HUD and Independent Agencies Subcommittee of the House Appropriations Committee. My Subcommittee has jurisdiction over the National Science Foundation, an important player in the creation and nurturing of NSFNet. I want you to know that as Chairman of the Subcommittee that has recommended millions of dollars for the creation of our nation's six federally funded supercomputer centers and for NSFNet itself, I feel extremely proud of the way in which that network has evolved.

The litany of accomplishments of the NSFNet is long and impressive and, I believe, those accomplishments reflect exactly what the Congress and NSF intended when setting up the network. Virtually all observers agree that NSFNet has been a resounding success. It is a stellar example of cooperation between the federal government, the academic research community and the private sector.

It is a homegrown system, if you will, that has given the United States clear leadership in computer networking, while at the same time providing boundless opportunities for students, scientists, the business community--individuals from virtually every walk of life--to access resources ranging from electronic bulletin boards to supercomputers across this continent and around the world.

NSFNet links our nation's institutions of higher education, including some 65% of all universities, government and research laboratories, representing a significant portion of the larger Internet system, and also representing the forerunner for the National Research and Education Network (NREN). As such it has truly become an invaluable asset critical to our nation's competitiveness. NSFNet, however, is no monolith. Rather it is a "network of networks," with its backbone now being tied into by some 5,000 individual networks, an estimated 1,500 of them from outside the United States, linking us to 36 other nations in Europe and the Pacific Rim.

I am pleased with the evolution of NSFNet to date because I believe it has provided one of the most outstanding examples of inter-agency cooperation and it has thus effectively made maximum use of our increasingly scarce federal resources. Importantly, federal investment in NSFNet has leveraged private investment. Merit Network, Inc., through its corporate partners has invested four dollars for every federal dollar expended. The regional education networks have invested many times more. As a result, the network that has been created continues to grow and to spread into all sectors of our nation's daily commerce and educational experience.

I believe that through its practical development and demonstration of networking techniques and capabilities, NSFNet has put us many years ahead of where we otherwise would have been in this endeavor. It has opened numerous commercial opportunities and has paved the way for the day when a network of this enormity can in fact be sustained by the private sector. In fact, through the efforts now underway to develop and demonstrate networking technologies, business opportunities have been created and will continue to emerge as we move toward broader and broader "mass service" markets.

Are we there yet? I think that is one excellent question for your hearings today. My personal feeling is that, even as commercial opportunities grow, NSFNet has much work still to be done. I would hope that we can keep the momentum and the leadership we have in this area. I believe government involvement can and should continue to be used to insure that the breakneck pace of advancement in the field of computer networking can be martialled to our further benefit.

Rather than impeding commercial opportunities, I believe NSFNet has fostered them. That is just what I believe the Congress intended. Likewise, I believe NSFNet is our best hope for staying at the leading edge of networking technology worldwide. Its work in creating networking standards and developing technology transfer systems will continue to stimulate new uses of the network and, therefore, further new commercial opportunities.

I congratulate you on your hearings today and I look forward to working with you on this critically important project and these important issues.

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STATEMENT BY U.S. REPRESENTATIVE JERRY F. COSTELLO (D-IL)

SCIENCE, SPACE, AND TECHNOLOGY SUBCOMMITTEE ON SCIENCE

"MANAGEMENT OF NSFNET"

MARCH 12, 1992

MR. CHAIRMAN, THANK YOU FOR CALLING THIS HEARING. I AM PLEASED TO BE HERE AS WE DISCUSS THE IMPLEMENTATION OF THE HIGH-PERFORMANCE COMPUTING PROGRAM. THIS HEARING, THE FIRST IN A SERIES ON THIS TOPIC, IS IMPORTANT AS WE MOVE TOWARD A MORE WORKABLE, NATION-WIDE COMPUTER NETWORK. I WOULD LIKE TO TAKE THIS OPPORTUNITY TO WELCOME OUR EXPERT PANEL OF WITNESSES. I AM PLEASED THAT MY COLLEAGUE FROM MICHIGAN, MR TRAXLER, HAS TAKEN SUCH AN INTEREST IN THIS SUBJECT, AND I WOULD LIKE TO WELCOME HIM HERE ALONG WITH THE OTHER WITNESSES. I AM LOOKING FORWARD TO HEARING TODAY'S TESTIMONY.

THE HIGH-PERFORMANCE COMPUTING ACT OF 1991 ESTABLISHED THE IMPLEMENTATION OF THE HIGH-PERFORMANCE COMPUTING PROGRAM. I AM VERY INTERESTED TO HEAR ABOUT THE ADVANCES THAT HAVE BEEN MADE IN THIS AREA. I AM VERY INTERESTED TO HEAR ABOUT NSFNET, THE RESEARCH AND EDUCATION COMPUTER NETWORK SUPPORTED BY THE NATIONAL SCIENCE FOUNDATION.

AGAIN, MR. CHAIRMAN, THANK YOU FOR CALLING THIS HEARING. I AM

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LOOKING FORWARD TO ADDITIONAL HEARINGS ON THIS TOPIC. THANK YOU, ALSO, FOR YOUR CONTINUED LEADERSHIP OF THIS SUBCOMMITTEE.

Mr. **Boucher**. The chair thanks the gentleman.

We extend the subcommittee's welcome to this panel of witnesses, and I will introduce each of them.

Dr. Eric Hood, the president of the Federation of American Research Networks, Inc.; Dr. Douglas E. Van Houweling, a member of the board of directors of the Merit Network, Inc.; Mr. Michael M. Roberts, the vice president for networking of EDUCOM; Mr. William Schrader, the president and chief executive officer of Performance Systems International, Inc.; and Mr. Mitchell Kapor, the chairman of the Commercial Internet Exchange Association.

We will, without objection, make a part of the record the prepared written statement of each of the witnesses, and the subcommittee would ask that each witness keep his oral statement to five minutes. That will give plenty of time for questions.

We welcome each of you, and, Mr. Roberts, let's begin with you this morning.

STATEMENTS OF MICHAEL M. ROBERTS, VICE PRESIDENT, NETWORKING, EDUCOM, WASHINGTON, D.C.; DOUGLAS E. VAN HOUWELING, MEMBER, BOARD OF DIRECTORS, MERIT NETWORK, INC., AND VICE PROVOST FOR INFORMATION TECHNOLOGY, UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN; ERIC HOOD, PRESIDENT, FEDERATION OF AMERICAN RESEARCH NETWORKS, INC., EXECUTIVE DIRECTOR, NORTHWESTNET, BELLEVUE, WASHINGTON; MITCHELL KAPOR, CHAIRMAN, COMMERCIAL INTERNET EXCHANGE ASSOCIATION, AND PRESIDENT, ELECTRONIC FRONTIER FOUNDATION, CAMBRIDGE, MASSACHUSETTS; AND WILLIAM L. SCHRADER, PRESIDENT AND CEO, PERFORMANCE SYSTEMS INTERNATIONAL, INC., RESTON, VIRGINIA

Mr. **Roberts**. Thank you. Mr. Chairman, it's a pleasure to be here today.

In February 1987, almost exactly five years ago, I presented testimony to your committee on the urgent need for a national computer network for research and education. In the course of your continuing work on the NREN since that hearing, other witnesses from the community, university community, helped to shape the legislation sponsored by this committee which became Public Law 102-194, the High-Performance Computing Act. We welcome this opportunity to assist you in oversight.

This hearing comes at an appropriate time, one at which we can celebrate the successes of NSFNET, can examine areas for improvement, and can collectively set our sights on the future of NSFNET and its successor network, the NREN. No one here today will dispute the successes of NSFNET; nor will anyone dispute the great importance which networking technology holds for future American success in science, research, education, economic competitiveness, and many other areas of our society.

The basic issue which faces us over the next several years is how to guide this unprecedented effort to establish an openly accessible, widely available computer network for the Nation's research and education community and ultimately for all Americans, how to make the transition from NSFNET to the larger but still developmental NREN and from the NREN to the national information infrastructure in the next century.

We have few models to follow. We know more about how not to do this than how we should proceed. For instance, we have good reasons not to establish a new Federal Networking Administration and equally good reasons not to establish a regulated private sector networking monopoly for research and education. There are, however, some useful lessons from the success of NSFNET that deserve consideration.

We should continue to encourage a bottom-up rather than a top-down approach to management, which has unleashed enormous amounts of creativity, energy, and initiative on campuses and at research centers all over the country. We should create positive incentives for change, take some calculated risks in pushing the technology. The team is strong; the odds are in our favor; the potential rewards are great. We should concentrate on results. We should measure success by numbers of new faculty and students brought on to the network and by numbers of new applications put into research and education and instruction use.

As a young officer on a Navy destroyer years ago, my skipper's favorite advice to me was, "You can't win a battle steering by your wake." The university community is looking forward, not aft, Mr. Chairman. With your continued interest and support, we are ready to steam in company with our colleagues in industry and Government toward a national network that realizes the goals that you have set for it.

Thank you.

[The prepared statement of Mr. Roberts follows:]

EDUCOM

United States House of Representatives
Committee on Science, Space and Technology
Subcommittee on Science

Hearing on National Science Foundation Network
March 12, 1992

Statement of Michael M. Roberts, Vice President, EDUCOM

Chairman Boucher and members of the Committee, I am pleased to present testimony today on behalf of the EDUCOM Networking and Telecommunications Task Force, a group of forty-eight universities with joint interests in the development of advanced computer networks to support research and education.

NSFNET Success. Over the past five years, NSFNET has compiled one of the most remarkable success stories in the history of American science. In this short period of time, through a partnership of government, industry and higher education, an advanced production network with the highest level of bandwidth available anywhere in the world has been designed and deployed in the research and education community in the United States. At the same time, the network has been transformed from one serving a narrow group of supercomputer centers and federally supported research sites into one with connections to more than six hundred colleges and universities and over a thousand public and private research sites. The global Internet family of research and education networks, of which NSFNET is a part, is growing equally rapidly and now reaches more than three-quarters of a million computer systems in more than one hundred countries. On the campuses of the members of the EDUCOM networking task force alone, more than one million students, faculty and researchers have gained access to NSFNET and the Internet. Of special note is the fact that NSFNET now connects more than a thousand high schools and several hundred libraries as a result of an effort by NSF and the regional networks to reach all levels of education.

In addition to the benefits within research and education, the success of NSFNET has materially aided the growth of a commercial market for Internet products and services which it is estimated will exceed four billion dollars in 1992, with growth at the rate of seventy-five percent a year.

This progress - in advanced network services, in access provided to the research and education community, and in technology transferred to the private sector - far exceeds the levels planned five years ago and is a tribute to the commitment of the NSFNET partners and to the able leadership of the Foundation and its Networking Division.

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In the remainder of this statement, I would like to focus on three key issues - a new cooperative agreement for NSFNET, a commitment to a common infrastructure with participatory governance for the NREN, and the linkage of the NREN program to establishment of a broadband communications network for all Americans. We are submitting additional EDUCOM background material on NSFNET and the NREN for the record.

NSFNET Competition for New Cooperative Agreement. Last November, the National Science Board approved a proposal by the Networking Division of NSF that it conduct a competition leading to new cooperative agreements for continuation of NSFNET for the period 1993-1996. In developing its proposal, NSF drew on studies and recommendations from a number of organizations within the networking community, including EDUCOM.

We believe that the plan for new cooperative agreements is an excellent one that not only provides stability of network service but promises to continue the progress in technology that has been an important feature of the current agreement. However, we wish to comment on the aspect of the intended plan that deals with competition for the award within the private sector and a related issue, raised in recent press articles, that NSF should be obligated, in a spirit of fairness, to provide a level playing field for competitors.

First, it should be understood that the new award will not be for standard commercial telecommunications services. It will be a cooperative agreement among partners in an effort to maintain and improve a leading edge, state of the art computer network which continues to meet the demands of the best science of which the United States is capable. That is the stated goal of the NREN legislation sponsored by your committee last year and of the program under development by the Administration. We should set our sights no lower.

Second, with respect to levelness of playing field, it is not and has never been the responsibility of a federal agency to guarantee market entry for a private sector firm. Nor is it the responsibility of federal agencies to transfer technology to the private sector in a manner which guarantees market entry. What NSF has done very successfully in the current award, and proposes to do again, is establish the criteria under which firms, or joint ventures of firms with public sector participation, may join with the Foundation in designing, testing, and deploying advanced network technology. The greater the size of the funding and resource commitment that is made by private sector firms in competing for the award, the greater the likelihood of rapid progress in advancing network technology. It is important to distinguish between competition for the new cooperative agreement, and the creation of a competitive market in the private sector for network services based on NSFNET/NREN technology. Progress made during the course of the next agreement will support and strengthen an already impressive level of commercial network services that has developed in the last several years.

Common Infrastructure for the NREN. At the present time, federal agencies participating in the HPCC program are preparing an NREN technical and management plan under the aegis of the Federal Networking Council (FNC). It is premature to comment on specifics of the plan until it has been released and reviewed. However, the view has been expressed by some that it is sufficient for the NREN to be just a family of largely independent networks, with connectivity and services under the control of individual agencies. This is clearly an unsatisfactory approach. It fragments the available federal resources. It confuses industry, which will be unsure of which agency approach will win out over others. It will reduce the rate at which the common infrastructure can be developed and implemented.

Some federal officials have the opinion that full support for the NREN would jeopardize mission critical network applications such as real time satellite data collection and nuclear energy experiments. These special applications have never been part of the NREN as envisoned by the universities and constitute a small fraction of total agency use of computer networks for research and education.

The universities, having made major investments in their campus networks and NSFNET connections, and having joined together to create and sustain the regional networks, believe that their federal agency partners in the NREN should make a similar commitment to a common networking infrastructure. Such a commitment must include agreement on mechanisms for participation in the creation and application of standards and policies for the network. When your committee continues its review of the Administration's NREN program later in the year, we believe this matter deserves further inquiry.

NREN Linkage to National Information Infrastructure (NII). As the revolution in computer networking has gained momentum in recent years, the potential value of NREN technology is being recognized in areas beyond the original leading edge, Grand Challenge research objectives. Mr. Chairman, you and Representative Oxley have taken the Congressional initiative in the House with the introduction of HR2546, which calls for rapid deployment of broadband technology in the national communications infrastructure. In a related development, the Computer Systems Policy Project (CSPP) has called for a broader vision of the NREN and specifically recommended that the Administration "establish a technology and policy foundation for an information and communications infrastructure for the future." The FCC has also taken note of these developments in holding future network hearings last spring and issuing a Notice of Inquiry into Intelligent Networks last December.

The university community believes that both the NREN and a broadband communications infrastructure for America are important, perhaps critical, national objectives. However, they are not the same, and neither should be treated as hostage or servant to the other. EDUCOM recommends that an explicit linkage be created between the two objectives. The NREN, guided by a government, industry and education partnership in developing and deploying advanced network technology, should be the means by which the country supports its research and education goals, and at the same time develops, tests, and transfers to the private sector its successes in technology.

The NII, guided by new federal and state communications legislation, should be the means through which a revitalized communications industry, utilizing digital and fiber optic technology, brings the benefits of the Information Age to every American. Forging a new national communications policy which protects the public interest and enhances the private sector role in providing advanced communications services is a difficult challenge. We in higher education have a major stake in the creation of a broadband communications infrastructure to help us fulfill our educational mission. We are prepared to assist the Congress in achieving this vision, which will assure continued U.S. leadership in a world which is rapidly becoming a global information society.

Summary. In conclusion, I would like to reiterate five key points:

First, NSF leadership in the development and delivery of NSFNET has been outstanding. Research and education are being extraordinarily well served by the NSFNET program, the sucess of which is obvious from every measure of network connectivity and use.

Second, the NSFNET program has positively stimulated the marketplace and there are a growing number of commercial providers of network services based on this technology where there were none only three or four years ago.

Third, we in the research and education networking community believe that the planned "recompetition" for a new NSFNET cooperative agreement is an appropriate and manageable compromise between conflicting objectives. It increases participation from the private sector while continuing a successful management structure proven during the current agreement.

Fourth, we urge the Congress to insure that the infrastructure and governance of the NREN reflect an effective partnership between the broadly based research and education community and the federal agency establishments so that standards and policies for the network will be formulated for the broadest applicability and greatest good.

Fifth, we recommend that the National Information Infrastructure and implementation of broadband communications envisoned in HR2546 be explicitly linked to the NREN program, though in no way merged, so that the NREN may take early advantage of broadband infrastructure to support research and education goals while leading in the advancement of the technology.

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Prior to joining EDUCOM, he was at Stanford University where he was Deputy Director of Information Technology Services, with executive responsibilities in Stanford's computing, communications, and information systems programs. During 1983-86, he directed the university's telecommunications modernization project, which installed a large digital voice switch and extensive fiber optic network facilities.

Mr. Roberts is a liberal arts graduate of Stanford and holds an MBA from the Stanford Graduate School of Business. He has been a consultant and advisor to many institutions of higher education, to the National Center for Higher Education Management Systems, and to the Navy Department. He is a member and has been an officer of a number of professional societies and organizations in computing and communications, including ACM, IEEE, the Internet Society and CAUSE.

He has been author, co-author and editor of numerous publications on networking and wrote the Introduction to "Campus Networking Strategies," published by Digital Press in 1988. His testimony before the United States Congress includes, "The Need for a National Higher Education Computer Network, " (House Science, Research and Technology Subcommittee, 1987), and "Antidotes to the Internet Worm," (House Telecommunications and Finance Subcommittee, 1989).

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United States House of Representatives
Committee on Science, Space and Technology
Subcommittee on Science

Hearing on National Science Foundation Network
March 12, 1992

Supplementary Information submitted for the hearing record by EDUCOM

I. Competition for new NSFNET Cooperative Agreement.

EDUCOM supports the NSF plan for a new cooperative agreement for continuation of NSFNET services. The plan (see NSF testimony for this hearing) is responsive to the concerns of many in the university community, as conveyed to NSF Director Walter Massey in a letter from EDUCOM President Kenneth M. King on October 28, 1991, which is included in this package of background information.

II. EDUCOM Vision of the NREN

The EDUCOM Networking and Telecommunications Task Force has adopted a comprehensive statement on the National Research and Education Network. It is contained in a Policy Paper dated March, 1990, which is included in this package. A number of policy positions advocated in the paper were included in S.272, the Higher Education Act of 1991, which was enacted in the last session. Others, especially those dealing with managment and governance, await further study by the Federal Networking Council as part of the NREN studies mandated by S.272.

III. Relationship Between NREN and National Information Infrastructure (NII)

Several members of Congress have introduced legislation dealing with modernization of the American telecommunications infrastructure, including HR2546 introduced by Representatives Boucher and Oxley. (A Senate version, S.1200, was introduced by Senators Burns and Gore.) EDUCOM supports Congressional initiatives in both the NREN and the NII. Their purposes, although related, require separate legislation, implementation and oversight. An article on the relationship between the NREN and the NII by EDUCOM Vice President Michael Roberts, published in the EDUCOM Review in its Summer 1991 issue, is enclosed.

Enclosures

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October 28, 1991

Dr. Walter Massey, Director
National Science Foundation
1800 G Street NW
Washington, DC 20550

Dear Dr. Massey,

For several years, the higher education community, especially the research universities who participate in the EDUCOM Networking and Telecommunications Task Force (NTTF), have worked with NSF in the creation of NSFNET, and in planning for the National Research and Education Network. Our role has been one of partnership with both government and industry. Many good things have come of this work, and there is great promise of larger contributions to science and education in the future.

I am writing to convey to you a recent statement developed by the NTTF, which expresses its concerns over the current situation regarding the expiration next year of the NSFNET backbone cooperative agreement. The statement is a strong one, and was adopted unanimously by the task force members.

I believe that an early resolution of the backbone issue is needed. Please call on me for any contribution you believe is appropriate.

Sincerely,

Kenneth M. King

Kenneth M. King
President

Enclosure

cc: Dr. Haberman
Dr. Brownstein
Dr. Wolff

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10/28/91

EDUCOM Networking and Telecommunications Task Force Statement on the Structure of the National Research and Education Network

The success of NSFNET, which now serves more than one-third of the nation's four year campuses and more than two-thirds of the faculty and enrolled students, has contributed materially to advancement of national goals in research, education and economic development. The transition to the Interim Interagency NREN, which is part of the Administration's High Performance Computing and Communications Program, is a critical step forward in the strengthening of the federal commitment to the goals of the NREN.

The three tier structure of a federally sponsored national backbone network, state and regional networks, and campus networks has been an important reason for the success of NSFNET. It has created and energized community-wide efforts to extend the services and connectivity provided by the network.

Equally important has been the partnership forged between government, education and industry to develop NSFNET, particularly the federally sponsored cooperative agreement with university and private sector organizations to operate the backbone. Leading edge networking components have been contributed by the private sector. Management and operating expertise has been provided from the university community. The result has been rapid growth in connectivity and performance, with the maximum leveraging of federal investment.

The goals of NSFNET for the support of science and education have been incorporated into the vision of the Administration's program contained in HPCC. The broader community addressed by that program, including federal mission agencies, libraries, and all levels of education, is now poised to move forward.

On the eve of the implementation of the NREN, uncertainty prevails because of the expiration in 1992 of the federal backbone network cooperative agreement for NSFNET. This uncertainty is damaging in numerous ways, including slowing of current momentum, reduced commitment to development of new network-based applications and services, and confusion among federal mission agencies regarding future network support for their programs.

It is imperative that the Federal Networking Council and NSF take immediate steps to clarify their intentions with respect to the stability of backbone services. A majority of the nation's academic science and research is now supported by NSFNET, and the continued availability of a high performance production network is essential.

The NTTF strongly believes that the best alternative for the Interim Interagency NREN is a multiyear cooperative agreement for backbone services based on the current three tier structure of NSFNET. We urge that NSF undertake a solicitation as quickly as possible, with the expectation that an award can be made by September, 1992.

A new, competitively awarded cooperative agreement will provide the greatest possible benefits to the national networking community, including - -

- continuation of the proven partnership and cost sharing arrangements among government, industry and education,
- the maximum leverage of limited federal networking funds to sustain an advanced network that will foster industrial competitiveness,
- the provision of stable services in the near term, allowing planning and deployment of the gigabit NREN to proceed on a parallel basis,
- a distributed structure which places accountability for performance close to the network's users.

Networking

POSITIONING THE NATIONAL RESEARCH AND EDUCATION NETWORK

If there is to be a National Information Infrastructure, what will be its relationship to the NREN?

Over the past several years, members of Congress and senior managers in federal agencies have become increasingly aware of the potential social and economic value of advanced computer networks. Many of the same arguments used during the advocacy for creation of the National Research and Education Network (NREN) are now being applied to networks for other areas of the economy.

Professor Michael Dertouzos of MIT, writing in *Technology Review*, recently said, "Computers will become a truly useful part of our society only when they are linked by an infrastructure like the highway system and the electric power grid, creating a new kind of free market for information services."[1] He went on to say, "The vision I have is of an information infrastructure that would make it easy for computers in every home, office, school, and factory to interconnect. Text, pictures, movies, software, designs, and much more would move easily and rapidly over this substrate."

Within the past few weeks, Representative Donald Ritter of Pennsylvania has proposed the creation of a national, fully integrated fiber-optics network infrastructure for the United States. Congressional hearings are expected later in the year.

These are just two signs of a movement with growing momentum. In some respects, the goals of this movement are similar to the goals that fashioned the Communications Act of 1934, which aimed to bring telephone service to all Americans. But the circumstances are vastly different in 1991 from the ones that existed in 1934, and the potential economic impact of a technology that can provide interconnection of powerful computers, as well as enabling humans to speak to one another, is vastly greater.

If there is to be a National Information Infrastructure (NII), what will be its relationship to the NREN? Are they complementary efforts, or are they competing for the same pool of resources? Since neither has been created yet, how do we sort out the pieces and plan intelligently?

These questions were the subject of both an EDUCOM Networking and Telecommunications Task Force workshop in January and an address by EDUCOM President Kenneth M. King in March at the National NET'91 conference.

COMMUNICATIONS REVOLUTION IN PROGRESS

Driven by advances in semiconductors and in fiber optics, the computer revolution has now become the computer and communications revolution. Within the past decade, the

By Michael M. Roberts

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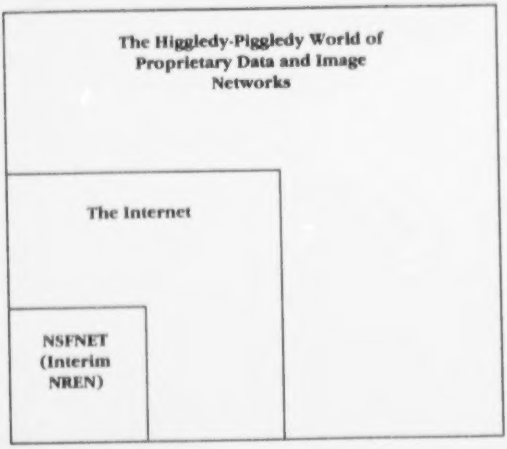
The Higgledy-Piggledy World of Proprietary Data and Image Networks
The Internet
NSFNET (Interim NREN)

FIGURE 1 — *The Universe of Computer Networks, Part 1—Today*

leading edge of communications technology has gone from megabits per second to gigabits to terabits. And once the enormous development costs have been funded, the direct manufacturing costs of advanced communications components will be amazingly cheap.

Gordon Moore, chairman of Intel Corporation, made a famous prediction about a dozen years ago: "Make your plans on the assumption MIPS are free." Today, an updated prediction would be: "Make your plans on the assumption BITS are free."

It will take decades for us to fully adjust to a world in which computing and communications power are very cheap compared with other economic costs. Much of our daily work routine is still built on the assumption, historically true, that computing power and communications bandwidth are scarce resources. We continue to spend hundreds of billions of dollars every year moving people to information rather than information to people.

Although we have in hand the raw technology that is driving the revolution, we are still far from completely understanding how to put it to work. But the rapid pace of scientific and technological development has made it possible to take great strides toward improved communications systems in the next decade; the challenge is to forge public policy that ensures that investments can be made wisely and benefits shared widely.

The NREN and the NII

There are multiple paths to achieving the long-range goal of an affordable, ubiquitous, high-performance communications infrastructure for the nation. The NREN will be an important part of the evolution to the NII, and the research and education community has important roles to play in this evolution.

Universities are the source of most of the basic scientific research that is needed before useful networking technology can be developed. Students, especially graduate students, carry state-of-the-art knowledge and skills into industry after graduation, becoming a major part of the technology transfer process in the economy. Campuses compose a major share of the market for advanced computer and communications services to support their research and education activities. Thus, the NREN will provide research, development, technology transfer, and market-making functions for the NII. The process of proceeding from technological feasibility to functional utility to consumer services on the NII will be enhanced by the work within research and education to build the NREN.

Progress toward the NREN at the federal level recently took a large step forward when the White House Office of Science and Technology Policy announced the federal High-Performance Computing and Communications (HPCC) program. Based on the work of many groups both within and outside of federal agencies, the basic plan for the NREN will build on the foundation laid by the research Internet, especially NSFNET, which has a special mission to connect federal research networks with colleges, universities, libraries, and other education-related organizations.

The NREN is taking shape as a partnership enterprise, with active participation from government, education, and industry. If Congress appropriates the $92 million in NREN funding for fiscal year 1992 that is included in President Bush's HPCC proposal, the current NSFNET will become the Interim NREN on October 1, 1991. It is growing very rapidly both in numbers of computers connected and in volume of traffic being carried. By the end of 1991, estimates are that the Interim NREN will have more than 1,000 sites connecting as many as 500,000 computers, serving 2 to 4 million individuals engaged in research and education activities, and moving more than 10 billion packets a month across the network.

Figure 1 is a schematic view of the current universe of computer networks. It is a diverse landscape of new and old technologies, a higgledy-piggledy world into which computer and communications firms have launched every imaginable form of proprietary system in search of markets and profits. Within that world, there is the rapidly growing Internet, a family of networks devoted largely to research and education, which all share a single packet architecture called TCP/IP. Within the Internet community is NSFNET. Each of these major network sectors is driven by a different set of service, technical, and economic factors, and each has its own barriers to adoption of advanced communications technology.

Figure 2 is a future view of the evolution of computer-based networks. On a worldwide basis, broadband digital communications technology will become pervasive and will form the underlying fast packet transport system for all forms of communications media.

Within the global world of Broadband-Integrated Services Digital Networks (B-ISDN), national communications infrastructures will form. The speed and architectural flexibility of B-ISDN will create dozens of new market opportunities for communications services of all kinds. For example, George Gilder, writing about the new network infrastructure in *Harvard Business Review*, asserts, "There will be as many potential channels as there are computers attached to the global ganglion. The culture will change from a mass-produced and mass-consumed horizontal commodity to a vertical feast with a galore of niches and specialties."[2]

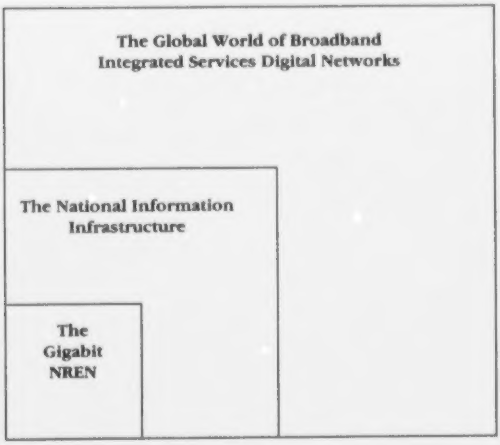
The Global World of Broadband Integrated Services Digital Networks
The National Information Infrastructure
The Gigabit NREN

FIGURE 2 ■ *The Universe of Computer Networks, Part 2—Tomorrow*

NREN Transition to NII

Building the NREN has frequently been described as akin to building a house, with various layers of the network architecture compared to parts of the house. In an expanded view of this analogy, planning the NII is like designing a large, urban city.

The NREN is a big new subdivision on the edge of the metropolis, reserved for researchers and educators. It is going to be built first and is going to look lonely out there in the middle of the pasture for a while. But the city will grow up around it in time, and as construction proceeds, the misadventures encountered in the NREN subdivision will not have to be repeated in others. And there will be many house designs, not just those the NREN families are comfortable with.

It is easy to oversimplify a large, complex undertaking such as the NREN, but at the same time we want to be careful not to project the image of an elite network reserved for an anointed few. Peter Likins, president of Lehigh University, said in his National NET'91 Conference keynote address, "This gigabit network [must] link together all sectors and elements in our society and economy."

Ten years of rapid progress in communications technology in the United States have not been matched by comparable progress in the formulation of telecommunications public policy. The NII is a concept that has the potential to cut through the legislative paralysis produced by competing special interest groups and bring the benefits of the technology to all citizens. The lessons we learn today in building the NREN will be used tomorrow in building the NII. ■

Endnotes

1. Dertouzos, Michael. "Building the Information Marketplace." *Technology Review*, January 1991, pp. 29–40.
2. Gilder, George. "Into the Telecosm." *Harvard Business Review* March/April 1991, pp. 150–161.

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The National Research and Education Network

A Policy Paper

Revised March 1990

EDUCOM Networking and Telecommunications Task Force

The National Research and Education Network

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SUMMARY

Goal. The goal of the National Research and Education Network is to enhance national competitiveness and productivity through a high speed, high quality network infrastructure which supports a broad set of applications and network services for the research and instructional community.

Benefits. The network will provide a wide range of public and private benefits, including the value to the domestic economy of:

- increased research productivity, instruction, and technology transfer;
- maintenance of U.S. leadership in research and education;
- improvement of our competitiveness in world markets;
- acceleration of the development of commercial networks and electronic information services.

Access. The network should be accessible by the entire United States higher education, research and development community for uses that are consistent with its goal.

Network Services. Services available on current networks must be modernized and enhanced to meet the needs of research users and to provide connection to specialized computer databases and computational facilities not accessible at the present time.

Research and Development. In recent years, the United States has lost much of the international lead it had in networking technology in the 1970's, due in part to an inadequate level of funding for networking research. It is critical that the recommendations of the White House Office of Science and Technology Policy for a five year, $198 million networking research program be adopted.

Network Structure. The optimum long-term model for the national network is a 3-level structure comprised of:

- a federally sponsored interstate backbone supporting high volume network service providers and at least one access node in every state;
- a mid-level tier of state and regional networks providing broad intrastate connectivity;
- a third level composed of individual campuses and government and industrial laboratories with responsibility for provision of access to end users.

Management. No single entity within the federal establishment, higher education or industry can accomplish all of the tasks associated with creation and operation of the national network. Effective management of the network will require formation of a new and unique partnership among federal and state government agencies; computer, communications and information services firms; and institutions of higher education. In order to ensure the broadest possible representation of users, developers and sponsors, this partnership should take the form of a public corporation.

Financing. Financing of the network should be a shared responsibility of federal research sponsors, educational agencies and institutions, and participating private sector organizations. The federal government, which has played the dominant financing role in research networks, should continue to do so.

As the network passes through its developmental and initial production stages, it should be mission funded by the appropriate federal and state agencies, with the expectation that as stable operation is achieved, a transition in funding to regular institutional and research budgets will occur.

Public support of the network is essential to insure effective and efficient development of network technology and services and to achieve at the earliest time the benefits associated with being able to bring the resources of the entire intellectual community into play in solving important national scientific, educational and economic problems.

BACKGROUND

Introduction. In 1990, the Administration and the Congress are considering legislation which would provide funding and direction to federal efforts in support of a national research and education network. The EDUCOM Networking and Telecommunications Task Force (NTTF), a group of sixty research universities and organizations, has been active in sponsoring the development of a national research and education network. It issued a major background document on the network in 1987.[1] Additional papers have been published since that time. (See Bibliography.) This policy paper, updated in March 1990, is intended to illuminate major issues associated with development of the network and to provide a set of recommendations for action by legislative and governing bodies.

History. Computer networks for research and education have been in a period of rapid growth since the early 1980s when timesharing became the dominant mode of use of large scale campus computers. Higher education has played a special role in computer networks, for it was within this community that the first modern network - the ARPANET - was designed, engineered and implemented. In many science and engineering disciplines, the use of local and wide area computer networks is now so integrated into daily activities that loss of network access severely impedes work. Critical functions dependent upon the network include remote control of experimental apparatus; remote sensing, collection and analysis of data; and exchange of results with professional colleagues for critique and publication. Networks and their associated computers have had a secondary benefit in permitting a large reduction in time required from researchers for necessary administrative functions.

Campus networks. Until recent years, the design of research oriented networks was derived from and tailored to the special requirements of individual groups and projects. As the use of microcomputers has spread widely on many campuses, demand has arisen for wider access and for more standardization in network hardware and software. Major institutional investments in networks also have been spurred by technical advances in communications devices and by falling prices resulting from semiconductor integration and miniaturization.

National network. A high level of public attention is being given to the creation of a national computer network for research and higher education. The White House Office of Science and Technology Policy (OSTP), issued High Performance Computing reports in 1987 and 1989 which included recommendations for a national research network.[2] Several other major studies have identified a national network as having the potential for a high payoff in improving research productivity. (See Bibliography).

The National Science Foundation, building on earlier work sponsored by the Defense Research Projects Agency, established a backbone network connecting thirteen major research sites in 1988, and is expanding it in both capacity and connectivity in 1990. Federal agencies are coordinating their research networks which are now affiliated with each other and known as the Internet.

A number of states, including New York, Michigan, Texas, Ohio and Pennsylvania, have established research and education networks. Other states have such networks under active consideration. More than twenty regional network consortiums also have been formed.

To serve as a focus for national network efforts, the EDUCOM Networking and Telecommunications Task Force has organized a National NET Conference, held annually in Washington, DC since 1988.

NATIONAL NETWORK GOAL

Goal. The goal of the National Research and Education Network is to enhance national competitiveness and productivity through a high speed, high quality network infrastructure which supports a broad set of applications and network services for the research and instructional community.

Objectives. To achieve this goal, the following objectives must be met:

- Foster development of advanced United States network technology and services;
- Increase technology transfer among government, industry and education regardless of the participating institution's size or location;
- Provide standardized access to and stimulate development of information resources, instruments, and computation centers whose characteristics make them national assets worth sharing;
- Create a cohesive, standard and consistent network architecture that will evolve gracefully to meet capacity, connectivity, security, management and service requirements.

BENEFITS FROM THE NATIONAL NETWORK

The network will provide a wide range of public and private benefits, including the value to the domestic economy of:

- enhanced research productivity, instruction, and technology transfer;
- maintenance of U.S. leadership in research and education;
- improvement of American competitiveness in world markets;
- acceleration of the development of commercial networks and electronic information services;

The network will provide access by researchers to large and expensive research apparatus, such as the space telescope, the international seismic network, and supercomputers, regardless of geographic location or institutional affiliation. It will leverage many billions of public dollars currently expended in support of these research projects by the relatively small expenditures necessary to connect individuals to the facilities.

The availability of the network will enable many owners of important databases to provide electronic access to that information who could otherwise not afford an independent network restricted to their own information.

Over time, the experience gained on the network will provide opportunities for improvement of the nation's entire educational system.

The lessons learned in forging and using an education, industry, and government partnership for the national network will be of value in this new area of joint enterprise within our social and economic system. Research collaboration and technology transfer resulting from use of the network will catalyze private investment in new product development in many areas of the economy and support recent federal initiatives in the commercialization of research such as the Technology Transfer Act of 1986 and the Omnibus Trade Bill of 1988.

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NETWORK ACCESS AND USE

A primary goal of the National Research and Education Network (NREN) is to create an electronic community of researchers and scholars with the broadest possible participation by individuals and organizations in education, industry, and government. Open access to the network is an essential element in achieving this goal. It is consistent with long-standing academic traditions of unimpeded access to books, journals and other information resources in libraries and elsewhere. This commitment is underscored in a recommendation contained in the recent National Academy report, "Information Technology and the Conduct of Research," *The national research network (should be) founded on the fundamental premise of open access to all qualified researchers/scholars that has nurtured the world's scientific community for centuries.*[3]

With few exceptions, existing campus, national, and international academic networks are open to faculty, students and staff for use in their research and scholarly activities. The access policies and procedures adopted for the national network should reinforce the openness of current practices within the limits of available funding and services.

The privilege of open access must be accompanied by both a high ethical standard of conduct by network users, and sufficient provision for the integrity of the network to make it highly resistant to mischievous attack. Theft, destruction or other misuse of intellectual property or legitimately protected research data must be avoided by both technical means, such as encryption, as well as by civil and criminal legal penalties.

As the national network evolves and becomes the primary information access resource within the academic community, mechanisms must be found to provide convenient access to and from private networks while preserving the noncommercial character of the NREN. This might be accomplished by purchase of bandwidth, connection of gateways, or other means.

Existing international connections of the Internet, which already reach dozens of countries, are valuable and must be continued to promote scholarly exchange, access to foreign resources, and to support international education programs in many institutions. Effort expended to support international access by U.S. sponsors and users of the network must be matched by an appropriate level of effort in other countries. Protection of proprietary national data and resources must be ensured. In the very small number of cases where it may become an issue, national security must be protected.

NETWORK SERVICES

Users of existing research and academic networks currently have available to them three principal types of network services; electronic mail and messaging, file transfer, and connection to remote host computer systems.

To meet future needs, these services must be improved in capacity, connectivity, functionality and usability. Plans for services on the national network must anticipate and provide for a capability which is matched to the rapid pace of development in the computers and high performance workstations connected to the network.

Short term. The services which are important to users of the national network in the short term are:

- national and international electronic mail, including easy access to directory service and electronic post offices;
- remote connection capabilities providing interactive access to host services such as:
  - supercomputer facilities
  - bibliographic and abstract databases
  - specialized databases such as satellite, medical, and legal data;
- file transfer, including complex documents and graphical (image) data;
- user support services including access to "how to use" information and the development of improved user interfaces;
- security and privacy services including provisions for encryption and access control;
- gateways providing easy access to commercial and foreign networks;
- provision of a collection service facilitating the attachment of services for which there is a usage fee to the network.

Long term. Over the longer term, new and enhanced services will be required to meet growth in demand and in the capabilities of workstations connected to the network, including:

- access to effective computer based conferencing facilities;
- transfer of information in multi-media formats, including high resolution graphics and sound;
- access to a rich range of data including federal and state data bases;
- ability to develop and use computer applications that are distributed across the network;
- facilities enabling scholars to dynamically and collaboratively build and maintain data bases that contain all that is known on a particular subject; and
- availability of a knowledge management system on the network providing a standard, consistent and intuitive interface to all network resources and services.

Commercial Services. Proposed NREN legislation provides that federal support for the NREN "be phased out when commercial networks can meet the networking needs of American Researchers."[4] This provision is intended to provide for an orderly transition from a dedicated research network to readily available commercial facilities as the country's public and private telecommunications networks are modernized and as demand for advanced network services grows in all sectors of the economy.

RESEARCH AND DEVELOPMENT

The 1989 White House Office of Science and Technology Policy (OSTP) High Performance Computing report, which amplifies and extends a 1987 proposal, contains basic recommendations for a national network to link government, research and higher education. Based on studies conducted by the Federal Coordinating Council for Science, Engineering and Technology (FCCSET), the report envisons a three phase plan in which current facilities are upgraded and a future network is developed.

In reviewing the 1987 OSTP proposal, a panel of the Computer Science and Technology Board of the National Research Council said, *Phase 3 presumes a new design based on research. The move from megabit per second networks to gigabit per second networks is revolutionary in a number of dimensions. Without appropriate research, phase three will not achieve a fraction of its intended impact. The critical issues involve a complex interaction of the following, all of which are closely coupled: switching technology, processor interfaces, protocols, connection-oriented communications, routing and layered architectures as well as coexistence with carrier environments.*[5]

The OSTP report recommends a five year basic research and development program for the Gigabit network, with $198 million in support from federal funding. Initial steps to plan the research program and demonstrate applicable technologies have been taken in 1988 - 1990 by NSF and DARPA.[6] In addition, this work will benefit substantially from continuing R&D investments within the communications industry in new broadband technology such as ultrafast packet switching, integrated opto-electronic devices, and synchronous optical network (SONET) developments.

In recent years, the United States has lost much of the international lead it had in networking technology in the 1970s, due in part to an inadequate level of funding for network research. It is critical that necessary research be initiated now so that advanced network facilities can be deployed during the next decade to meet rapidly growing demand from the research community. The recommendations of the FCCSET study group included in the OSTP report are sound, and represent the minimum level of research funding which should be incorporated into legislation supporting the national research and education network.

Failure to move aggressively in this important technology area will not only jeopardize our ability to conduct advanced research in all scientific disciplines, but it will likely lead to loss of international technical leadership and markets for high speed communications equipment as the well funded programs of other nations outstrip those of the U.S.

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NETWORK STRUCTURE AND MANAGEMENT

The informal collaboration among network researchers, users and sponsors which has guided the growth of existing academic and research networks is inadequate to meet the future needs of the national network for reliability, user support and the timely introduction of improved services, technology and capacity. The growth of campus and research site networks will increase the population of active users from an estimated one million today to four to six million (approximately one-half of the United States academic and research community) within ten years. Computer connections to the network, now numbering an estimated 50,000, will increase by at least a factor of ten over the next decade as use of the network expands and new generations of personal computers and workstations are introduced.

Long-term model. For the long term, the optimum model for the national network is a 3-level structure comprised of:

- a federally sponsored interstate backbone supporting high volume network service providers and at least one access node in every state;
- a mid-level tier of state and regional networks providing broad intrastate connectivity;
- a third level composed of individual campuses and government and industrial laboratories with responsibility for provision of access to end users.

This model is similar to the one being used for development of NSFNET at the present time, and it should be adopted for the national network.

Management objectives. Over the next ten years, the success of the national network will be measured by the ability of its sponsors and managers to achieve the following objectives:

- Plan and execute an accelerated program of basic and applied networking research;
- Converge in an orderly manner the present collection of independent research and academic networks with limited connectivity and overlapping functions and missions;
- Continuously and reliably expand network services to the research and academic community;
- Make available new networking technology which provides the tools necessary to conduct world-class science, research, and education;
- Provide a central core of consistent and compatible standards, policies and procedures for the network while fostering decentralized and client centered operational and support services.

Partnership Roles. No single entity within the federal establishment, higher education or industry can accomplish all of these tasks. An effective partnership will require active participation and support from all three sectors, as well as a new public corporation. The principal responsibility of the new network corporation should be to plan and oversee the effective operation of the network, not to provide facilities or operations support. Its governing board should be composed of individuals who are broadly representative of network users, developers, and sponsors.

The new organization should be managed to maximize the unique contributions which each of the partners is able to make to the accomplishment of the goals of the national network. The federal and state governments should have a major role in leadership, funding and formulation of public policy. Industry should have a major role in providing technology and facilities for the network, and for commercial services accessible through the network. Higher education should have a major role in defining network policy and service requirements, in performing basic research in networking technology, in providing pre-commercial and non-commercial services, and in providing network operational support.

NETWORK FINANCING

Existing research and academic networks are financed in a variety of ways, reflecting the diversity of funding arrangements within the communities. The federal government, through its research sponsoring agencies, has historically been the major source of funding for inter-campus network facilities, with the current level estimated at $50 million per year.[2]

Institutional investments. In addition to federal dollars expended on networking research and operations, there are significant amounts, largely undocumented, being spent by individual institutions and research organizations to modernize campus networking and communications facilities, including both capital expenditures for equipment, as well as increased annual operating budgets for networking and data communications. In total, the rapidly growing expenditures at the several hundred campuses with active networking programs are estimated to exceed current federal and state network funding by a substantial margin.

These network costs, both campus and extra-campus, are part of significant new investments in computing to support research and instruction programs. College and university purchases of computer equipment and software currently exceed two billion dollars a year. It is widely recognized that the benefits to be derived from these computing investments are dependent upon effective networking of the machines and their faculty, research and student users to each other, to research apparatus and facilities, and to national electronic databases.

Federal investment in the national network will have a significant multiplier effect on individual campus investments, greatly increasing the overall value of the network.

Financing mechanisms. The financing of the national network should use existing mechanisms where appropriate, and in cases where new arrangements are necessary, they should maintain the maximum possible degree of flexibility and institutional option consistent with equitable distribution of the cost of network use.

Cost recovery. The stability of cost and operating data associated with present well established commercial accounting arrangements for telecommunications services will not exist in the national network for some years. Given the network's mission of providing continuously leading edge capability to support the highest caliber of research and education, such stability may be deferred for a long period. Until a useful and detailed accounting procedure is available, the present arrangements in which federal, state, university, and private sector costs are allocated on a capacity related, fixed fee basis is considered a fair method of financing the network.

Funding level. The FCCSET study group projected that annual network operating costs (not including campus level expenditures) would rise from a Stage 1 development level of $65 million to a Stage 3 level of $200 million when gigabit technology is deployed to several hundred primary sites.[2] This investment, which is modest when compared to the total federal research expenditure of more than seventy billion dollars annually, assumes critical importance to the future success of the national network as it will form the core on which campuses will depend for connectivity and function. This level of operational funding is essential to deployment of the national network and to realization of its goals.

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EDUCOM NETWORKING AND TELECOMMUNICATIONS TASK FORCE
March, 1990

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Mr. BOUCHER. Thank you very much, Mr. Roberts, and the subcommittee does appreciate your conciseness in keeping your statement to five minutes, and I hope that you have set an example for the balance of our witnesses this morning.

Dr. Van Houweling.

Dr. VAN HOUWELING. Mr. Chairman and members of the subcommittee—

Mr. BOUCHER. Could you move the microphone over in front of you, please, sir? That's it.

Dr. VAN HOUWELING. Okay. Mr. Chairman and members of the subcommittee, I'm pleased today to appear here on behalf of Merit Network, Incorporated, a not-for-profit organization of nine Michigan universities. For the past three and a half years, Merit has successfully managed and operated the NSFNET backbone service in partnership with IBM and MCI.

The Merit proposal, which won the stiff NSF competition in 1987, committed us to two key elements: first, we built a successful 1.5 million bit per second—or T-1 in the parlance—network on schedule and under budget; and we have upgraded the backbone service to 45 million bits per second, or T-3. Speed is required by the applications, by the Federal program direction, and by traffic growth.

Second, we have significantly leveraged Federal funds with private sector and State contributions. Hardware and software are supplied by IBM, connectivity by MCI, and funding by the State of Michigan's Strategic Fund. Every dollar spent by NSF on the backbone service has been matched by more than four dollars from the Merit partnership.

Since its initial deployment, backbone traffic has grown by nearly 7,000 percent, with an 11 percent monthly compounded growth rate. This extraordinary growth has required the Merit partnership to develop and introduce new technology and motivated the 1990 formation of a new organization.

Advanced Network and Services, or ANS, is a not-for-profit organization dedicated to the advancement of education and research through computer networking. Members of the ANS board represent industry and higher education across the Nation. IBM and MCI, in keeping with their support of the National Networking Initiative, contributed start-up funding for ANS.

With NSF approval, Merit contracted with ANS to provide the NSFNET backbone service. Thus, we began the process of privatizing the network, a goal which Congress has since recognized in its High-Performance Computing Act of 1991.

To provide commercial service, ANS last year established a subsidiary, ANS CORE Services. No NSF funding flows to CORE systems, and under agreement with NSF, a portion of the commercial fees are used to further develop the network.

Where do we stand today? First, access to the network has exceeded even the most optimistic visions. The original solicitation suggested that NSFNET would ultimately reach 10,000 scientists and researchers at 200 or more campuses and research centers. After only three and a half years, NSFNET already provides access to millions of scholars and researchers in over 1,000 institutions across the United States. Over 650 colleges and universities are connected, representing about 80 percent of the Nation's student population and 90 percent of the Nation's Federally sponsored research. NSFNET now provides access to more than 1,000 high schools and several hundred libraries through the joint efforts of the National Science Foundation and the regional network.

Second, Federal funds have been extraordinarily multiplied. Every dollar devoted to the backbone has yielded an investment of at least $10 in regional and campus networks. The bottom line is, every Federal dollar has stimulated at least a $40 investment in an emerging technology critical to the Nation's international competitiveness.

Third, in keeping with the goals of the High-Performance Computing and Communications Program, the NSFNET program is an extraordinary success in catalyzing new technology. The United States now leads the development of an entirely new global industry. American companies lead the world in internet technology. Large carriers, like Sprint, AT&T, MCI, Ameritech, and Bell Atlantic, are working vigorously to establish their presence, and smaller companies and regional networking organizations are growing rapidly. Merit and ANS are simply two of the many organizations in this rapidly growing marketplace.

Fourth, and perhaps most important, Government, higher education, and industry are working together to build a critical infrastructure for our Nation. No one argues with the proposition that knowledge and information are the most critical commodities for our Nation's future. The NSFNET example and experience are providing the United States with the tools it needs to succeed in that future.

NSF's vision and program have led us to this uniquely American approach to innovation. With a modest investment, they have energized the Nation and created a highly competitive new marketplace. This program plan and strategy for introducing future technology will sustain that momentum. Merit and its partners have been delighted to contribute to this extraordinary development.

Thank you very much.

[The prepared statement of Dr. Van Houweling follows:]

Hearing on the National Science Foundation Network
U. S. House of Representatives
Subcommittee on Science
March 12, 1992

Testimony of Douglas E. Van Houweling
Merit Network, Inc.

Mr. Chairman, members of the Committee, I am pleased to appear on behalf of Merit Network, Incorporated, a not-for-profit organization of nine Michigan universities. Those universities include: University of Michigan, Saginaw Valley State University, Michigan State University, Wayne State University, Eastern Michigan University, Oakland University, Western Michigan University, Michigan Technological University, and Central Michigan University.

As you know, Merit is responsible for the management of the NSFNET backbone service under a cooperative agreement with the National Science Foundation (NSF).

You have requested that I address the following in my testimony:

-- The current arrangement for operation of NSFNET;
-- The NSF's plan for recompetition of the award for operation of the NSFNET backbone; and
-- The key issues Congress needs to consider to help ensure a successful evolution of the current Internet to the NREN.

Before I address these specific points, let me make a few comments on the history behind the current cooperative agreement between Merit and the NSF.

A Brief History

Merit has been involved in data communications networking since the very beginning of the technology's development in the United States. Established in 1966, Merit began operating an inter-university packet switching data network in 1972. Today Merit provides the State of Michigan with Michnet, a state-wide data communications network. We are proud to have been pioneers in the development of this critical technology for the future.

The current management and operation of the NSFNET backbone service is based on Merit's cooperative agreement with the National Science Foundation (NSF).

In 1985, the NSF established five national supercomputing centers, and in 1986 linked those centers together at 56 kbps, thus establishing the original NSFNET. That original network proved so useful that it quickly became overloaded, and applications such as remote computing were increasingly difficult to perform. In addition, a number of regional networks wished to connect to the supercomputing centers and to each other.

As a result, in 1987 NSF solicited† proposals from organizations "to manage, operate, and continue development of a national ... network." A key point in that solicitation was that "the managing organization shall apply its expertise and creativity in devising innovative approaches.... proposers are encouraged to suggest alternate architectures and approaches that may be more appropriate, more cost effective, or offer better service."

The solicitation also stated:

"The purpose of the NSFNET program is to provide scientists and engineers with a national computer communications network that will evolve to a national internetwork system for improving communication, collaboration, and resource sharing.... NSFNET is dynamic. It will change with evolving network affiliations, improved technologies, competing communications costs, varying traffic load, and other similar factors."

The solicitation went on to describe NSFNET's overall architecture to be a "three-level hierarchy:

(1) A transcontinental 'backbone' network, interconnecting
(2) a number of autonomously administered 'second-level' networks.... each of which interconnects
(3) as many as 30 academic, industrial, and/or government research campus networks."

Merit believed that higher education participation would be critical to the success and to the community's use of the backbone. Further, Merit's analysis of the needed capabilities, its understanding of the available funding from NSF, and the resulting required level of effort led to the conclusion that successful service would require a partnership with the computing industry and the telecommunications industry.

On August 14, Merit submitted a proposal in partnership with IBM and MCI. Two key aspects of that Merit proposal were:

1) The design and deployment of a 1.5 million-bit-per-second (T-1) network from the beginning, with a option for providing 45 million-bit-per-second (T-3) service after 1990 if NSF so desired;

2) Significant cost sharing, including hardware and software from IBM, connectivity from MCI, and funding from the State of Michigan's Strategic Fund.

In total, this cost sharing was more than double the proposed five-year NSF budget of $14 million.

It is important to underscore that the NSF process was a highly competitive one. We understand that a number of companies in the telecommunications and computing industries as well as other universities submitted proposals.

On November 19, 1987, NSF announced a five-year cooperative agreement with Merit for the design, engineering, construction, and operation of a national backbone network service. NSF had the capacity to extend and modify the agreement, develop additional agreements and subcontracts, and provide additional funding as needed over the life of the agreement.

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† Project Solicitation for Management and Operation of the NSFNET Backbone Network, National Science Foundation, OMB 3145-0058.

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In July 1988, only seven months after the award, Merit and its partners deployed the backbone on schedule and within budget. Since that initial deployment, the NSFNET services have enjoyed phenomenal success due to NSF's leadership and the hard work and investment of a number of industry participants. The traffic on the backbone has grown almost 7,000 percent, an average of 11 percent compounded every month, and new applications and uses are constantly emerging. This has been a challenge to manage, but even more of a challenge has been the growth in the number of networks that are now reachable via the NSFNET service. This number has doubled every year and is now approaching 5,000 networks worldwide.

In fact, the growth of the network and its use was so great that it posed significant technical challenges. Recall that, at the time, NSF and the Merit partnership were working on the leading edge of a new internetworking technology. Some of the technical hurdles were very difficult to overcome.

To accommodate this extraordinary growth, the backbone service was continuously upgraded -- new connections were added, speeds increased, and routing and network management technology enhanced. Both NSF and the partners added new resources. NSF's additional funding commitment was augmented by continued major cost sharing by IBM and MCI.

The option to upgrade the network to T-3 speeds was exercised by NSF for four reasons:

1) Many of the emerging applications, such as graphic user interfaces that facilitated visualization of medical images and other applications‡ such as ozone depletion, air pollution and fuel combustion studies, as well as the emerging distributed file systems, required broader bandwidth.

2) Many federal studies, including the September 1989 FCCSET report as well as the OSTP program, proposed the need to upgrade the speed of the network over time to T-3.

3) The projections of the extraordinary growth clearly indicated that the T-1 network would be congested unless additional capacity (e.g. by an upgrade to higher speeds) was deployed.

4) Finally, one of the overriding goals of all parties involved in the NSFNET backbone service has been to continue to push the limits of communications technology and maintain the U.S. competitive advantage in this field.

Leading-edge technology has been required all along the way. The challenge of incorporating such developmental technology in a production network has presented all of us with many problems, but it has also stimulated United States' research, industrial and commercial leadership in fast-packet switching data networking.

Organizational Change

As the backbone network service grew in complexity, and was re-engineered, the underlying organization also had to evolve. Increased focus and resources were needed to keep pace with the increasingly complex technical, business and policy environment.

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‡ Grand Challenges: 1993 High Performance Computing and Communications, FY 1993 U.S. Research and Development Program, Supplement to the President's FY 1993 Budget.

Therefore, with the agreement of NSF, on September 14, 1990, Merit, IBM, and MCI announced the formation of a new, not-for-profit corporation, Advanced Network & Services, Inc. (ANS).

The certificate of incorporation states that ANS:

1) "is ... dedicated to the advancement of education and research in the interest of improving the ability of the United States to compete in the global economic environment";

2) "will concentrate on computer networking and related services,";

3) "shall help establish a high-speed computer network which will be maintained at the leading edge of technology,";

4) "will ... help to expand the access to and interchange of information technology resources among academic, government and industry users,"; and

5) "will engage in research and development work which will ...contribute to United States preeminence in high speed networking...."

ANS' board, of which I serve as Chairman, is broadly representative, its members drawn from industry and higher education across the nation. Both IBM and MCI made major contributions in the form of grants to ANS' establishment. In addition, both IBM and MCI bear substantial cost in providing equipment and services to ANS.

With the approval of the National Science Foundation, Merit contracted with ANS for backbone network service. The goals were:

1) To provide a stable nationally representative organizational and financial platform for the future of the NSFNET backbone service and its successors.

2) To begin the process of privatizing the network.

3) To provide a foundation for interconnecting commercial service providers with higher education and research enterprises.

It is important to note that there were no government asset transferred to ANS at the time of its establishment. The network hardware itself is owned by ANS, and the communications facilities are leased by ANS from MCI and others. Federal agencies, regional and state networks, other commercial networks, universities and private industry pay for their attachments to the ANS network.

The formation of ANS brought to the network's development an increased amount of private sector participation -- a goal which Congress recognized in passing the High Performance Computing Act of 1991. The formation of ANS also was heralded by Senator Al Gore (D-TN), who stated that "Just as private contractors helped build the interstate highway system, this new corporation will help build the national information superhighway today's information age demands."

This increased participation of the private sector, spurred by ANS's entry into the field, also broadened the funding base and increased competition in the network's development. For example, ANS has also submitted proposals to provide services to emerging state networks with other interexchange carriers. In addition, new test equipment vendors have been integrated into the network to improve network management for all users at very high speeds.

To accomplish the third goal, ANS on May 30, 1991 established a for-profit subsidiary, ANS CO+RE Systems, Inc., to serve commercial customers and link them to the research and education community. Discussions with representatives of the regional networks, FARNET, and the NSF were held to ensure that the cost of providing commercial services are completely reimbursed through non-governmental sources. Fees from commercial use of backbone services, minus operating expenses and taxes, are returned to ANS for reinvestment in the network infrastructure.

The creation of ANS CO+RE and its work with regional networks blazed the trail for major segments of the Internet to carry commercial traffic, creating many new commercial Internet service providers and taking a major step forward in pursuing the vision of the original drafters of the program.

The Results

Less than four years later, it is instructive to assess the results of the NSF's visionary plan.

First, access to the network has exceeded the most optimistic visions. The solicitation said, "It is anticipated that over the next five years NSFNET will reach more than 10,000 mathematicians, scientists, and engineers at 200 or more campuses and other research centers."

In fact, the NSFNET today provides access to millions of scholars and researchers in over 1000 institutions across the United States. Over 650 colleges and universities are connected representing approximately 80 percent of the nation's student population and 90 percent of the nation's federally sponsored research.

Further, NSFNET now provides access to more than a thousand high schools and several hundred libraries through the joint efforts of the NSF and the regional networks.

This data network is going to open up entire new vistas of information and learning techniques for America's students from kindergarten to post-graduate institutions. I believe it will spark a revolutionary change in the way we prepare our children for the challenges of the future.

This evolving network is clearly an example of where economies of scale make a difference in serving many diverse communities.

Second, federal funds have been leveraged in an extraordinary fashion. Every dollar spent by NSF on the backbone service is matched by more than four dollars from Merit and its partners. Further, each of these dollars has yielded an investment at least ten times larger in regional and campus networks.

Mr. Chairman, the bottom line is, every Federal dollar has stimulated at least a forty-dollar investment in an emerging technology critical to the nation's international competitiveness. With a small expenditure of federal funds, the government has spurred the development of an entirely new set of technologies and applications that will dramatically enhance our ability to compete in world markets.

Third, a new industry has begun to develop in which the United States not only leads technologically, but in the market. American companies lead the world in internet technology, and are growing rapidly. Not only are large communications carriers like Sprint, AT&T, MCI, Ameritech, and Bell Atlantic working vigorously to establish their presence, but smaller companies and regional and state networking organizations are growing rapidly. Merit and ANS are simply two of the many organizations in this rapidly growing marketplace.

In keeping with the goals of the High Performance Computing and Communications Program, the NSF program has been an extraordinary success in stimulating the growth of a critical new technology. The program grew from a federal government commitment to seed an infant technology, was helped and nurtured by a committed partnership of educational and research institutions, state government and private enterprises, and it is now demostrating its potential. Already, the United States is the world leader in exporting this new communications technology and its many related applications. Those increased exports are making a positive difference in our balance of payments.

This network is envied worldwide. It has allowed the U.S. to lead in building a high-speed data communications infrastructure. We are pioneering technological applications that will be among the most critical for research, education, and business in the 21st Century.

Fourth, and perhaps most important in the long term, is that government, higher education, and industry are working cooperatively to build a critical infrastructure for our nation. No one argues with the proposition that knowledge and information are critical commodities for our nation's future.

Key Issues For The Future

The NSFNET example and experience is providing the United States with the tool it needs to succeed in that future. NSF's vision and program have led us to this uniquely American approach to innovation. With a modest investment, they have energized a nation. Their program plan and strategy for introducing future technology will sustain the momentum. We believe NSF's program plan for recompetition of the cooperative agreement is appropriate, but entails substantial technical and management challenges.

Congress should consider the following key issues to help ensure a successful evolution to the NREN.

1) The successful triad of government, academic, and private industry should continue because it spawns innovation and technology transfer which makes this country stronger.

2) Any future program should seek to stimulate investment from private industry as the current program has so successfully done.

(3) Congress should create an environment in which the natural tendencies for fragmentation of federal efforts are overcome by a coordinated program led by the NSF.

Merit and its partners have been pleased to have played their part in this extraordinary national program.

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Mr. **Boucher**. Thank you very much, Dr. Van Houweling.

Mr. Roberts—I'm sorry, Mr. Roberts, we have heard from you. Dr. Eric Hood, President of the Federation of American Research Networks.

Dr. **Hood**. Mr. Chairman and members of the committee, I am truly pleased to present testimony today on behalf of the Federation of American Research Networks, or FARNET.

FARNET is a nonprofit association chartered to support the evolution and widespread adoption of data networking to enhance research, education, and economic development. Our 32 members include operators of State, regional, and national computer networks, telecommunications vendors, and other organizations of like mission. A majority of the private network providers, including Advanced Network Services, the California Education and Research Foundation Network, and Performance Systems International are members, as are most of the other regional and State public networks connected to the National Science Foundation network. The vast majority of this Nation's networked research and education institutions receive their access to the NSFNET through FARNET member organizations.

The subcommittee has asked FARNET to assess NSF's efforts to provide networking support to science and engineering research and education communities. The Networking Division at NSF has done an exemplary job. The NSFNET is a bona fide success. Over the past five years, NSF has created and maintained an operational infrastructure which has successfully sustained exponential growth, as measured by the increase in number of users, the increase in number of connected sites, and the increase in traffic volume.

During this period, the NSFNET has matured and expanded from its initial focus of serving a small group of supercomputer users at Federally sponsored research facilities to today's network which connects over 1,000 institutions, including over 660 colleges and universities. Approximately 70 percent of our Nation's student population attending four-year colleges and universities have institutional access to NSFNET. Over 90 percent of the Nations' Federally sponsored university-based research is conducted at institutions connected to the NSFNET.

The NSF facilitates collaboration among researchers and scholars by enabling them to communicate electronically, to share text, data, and graphical images, and to access geographically dispersed computing and information resources.

In the Pacific Northwest, educators in a cooperative medical education program in the four-State region of Washington, Alaska, Montana, and Idaho use the network to collaborate on curriculum development and to exchange course materials. A pilot project to provide shared regional access to Medline data, biomedical bibliographical database, is now in final test.

Throughout the past five years, NSF has provided clear and consistent technical leadership and direction. Thus, the NSF has successfully leveraged technically sound investments on many university and corporate campuses. One regional network, Westnet, estimates that for each Federal dollar invested in the NSFNET program, the Federal Government leverages $31 in State and local funding.

At their annual meeting late last autumn, the Pacific Northwest Economic Region, an association of legislators in the States of Washington, Oregon, Alaska, Idaho, and Montana, endorsed the communications standards of the NSFNET, known as internet protocols, for use by their respective State government agencies. These key legislators were incented to make this critical decision in anticipation of the NREN program and the promise of national and international connectivity for their States.

These achievements testify to the incredible progress which has been made in the past several years toward creating a national research and education network infrastructure. Yet to continue the momentum we have begun will require strong programmatic leadership in the emerging NREN. The correct partnership of Government, academia, and industry will be required to continue the development of new, precompetitive, high-performance computer communications technologies and to support the extension of access to this national information resource for underserved communities including K-12 education, libraries, and health care.

Thank you, Mr. Chairman.

[The prepared statement of Dr. Hood follows:]

U.S. House of Representatives Committee on Science, Space, and Technology

Subcommittee on Science
Hearing on the National Science Foundation Network (NSFNET) and the National Research and Education Network (NREN)

March 12, 1992

Statement of Dr. Eric S. Hood
President, Federation of American Research Networks (FARNET)
Executive Director, NorthWestNet

Chairman Boucher and members of the Committee, I am truly pleased to present testimony regarding the National Science Foundation Network (NSFNET) and the National Research and Education Network (NREN) on behalf of the Federation of American Research Networks (FARNET).

FARNET is a non-profit association chartered to support the evolution and widespread adoption of data networking to enhance research, education, and economic development. Our 32 members include operators of state, regional, and national computer networks, telecommunications vendors, and other organizations of like mission. A majority of the private network providers [e.g., Advanced Network Services (ANS), California Education and Research Foundation Network (CERFnet), and Performance Systems International (PSI)] are members, as are most of the other regional and state public networks connected to the National Science Foundation Network (NSFNET). FARNET also has liaison relationships with other national and international organizations with interests in networking, including the Coordinating Committee on Intercontinental Research Networks (CCIRN) and the Internet Engineering Task Force (IETF).

As a membership association, FARNET limits its public commentary on policy to questions which the membership has considered as a body. With regard to the issues before the Subcommittee, and in response to your questions regarding the NSFNET and the National Research and Education Network (NREN) as posed in your letter of February 28, 1992, the FARNET Board of Directors would like to communicate the following observations based on workshops, conferences, and focused electronic discussions conducted over the past six months.

"Assessment of NSF's efforts to provide networking support to the science and engineering research and education community, including your views on the current arrangement for operation of NSFNET."

The Division of Networking and Communications Research and Infrastructure (DNCRI) at NSF has done an exemplary job of enabling the provision of network access to the nation's research and education communities. Over the past five years, NSF has created and maintained an operational infrastructure which has successfully sustained exponential growth, as measured by the number of users, by the number of connected institutions, and by the volume of network traffic. In addition, NSF has demonstrated technical leadership in establishing standards for data networking and for supporting research into very high speed technologies. Furthermore, NSF's investments, which have been modest by Federal standards, have leveraged significant funding commitments on university campuses, from corporations, and from state governments.

Ten years ago in 1982, the Defense Advanced Research Project Agency's ARPANET deployed then state of the art technology to connect military facilities to approximately 10 or 15 research universities. The computing devices attached to the network numbered in the hundreds and ARPANET trunk speeds did not exceed 56 thousand bits per second. The custom-built hardware needed to accomplish the switching cost on the order of $100,000 to $200,000 per node. Computer scientists and engineers were the only regular users of the network.

In contrast, trunk bandwidths in the NSFNET now routinely exceed 25 times the capacity of the original ARPANET (or 1.5 million bits per second), and many trunks are capable of supporting 700 times this amount (or 45 million bits per second). The cost of the switching hardware is at least one, and can be two, orders of magnitude smaller. The computing devices that we use daily, from very fast personal computers to graphics workstations to parallel supercomputers, were barely envisioned by designers 10 years ago.

Today's NSFNET allows researchers and scholars to communicate electronically, to exchange text, data and graphical images, and to access geographically dispersed information resources. The NSFNET now connects over 630 colleges and universities, or approximately 35 percent of our nation's four year institutions of higher education. Over 90 percent of the nation's Federally sponsored research is conducted at institutions of higher education connected to the NSFNET. Approximately 70 percent of our nation's student population attending four year colleges and universities have institutional access to the NSFNET. This communications and information infrastructure enables computer users at sites across the nation to share information and to work collaboratively on common tasks and projects. More than 1,000 institutions, including colleges, universities, and not-for-profit, government, and corporate research facilities representing every state, are currently connected to the NSFNET. Today's NSFNET is also an important part of a larger communications network, the global Internet, which connects an estimated 750,000 computers and 5 million users worldwide.

Such broad interconnectivity between our nation's colleges and universities has opened new avenues for communication among the nation's scholars. The NSFNET now empowers researchers and educators at more than just the Carnegie research universities. Over the network, faculty and students at comprehensive and liberal arts colleges now routinely collaborate electronically with their counterparts at our nation's elite research universities.

Over the past five years, NSF has provided national administrative and technical leadership in the field of research and education networking. Throughout this period, NSF has provided clear and consistent technical direction promoting the deployment of interoperable and open data communications technologies. The NSF has enabled the development of a national networking infrastructure capable of supporting communications across diverse computing platforms manufactured by multiple vendors. For those that have followed NSF's lead, inter-institutional connectivity across campus, corporate, state, regional, and national boundaries is now possible. Thus NSF has successfully leveraged sound technically investments on many university and corporate campuses in anticipation of national and global interconnectivity. One regional network, WESTnet, estimates that for each Federal dollar invested in the NSFNET program, the Federal Government leverages thirty-one dollars of state and local funds.

"Regarding NSF's plan for recompetition of the award for operation of the NSFNET backbone: Did the plan take into account the views of the network user and network provider communities?"

In constructing the plan for recompetition of the award for operation of the NSFNET backbone, NSF both solicited and implemented recommendations from network users and network providers represented by FARNET. With support from the National Science Foundation, FARNET conducted a workshop and electronic discussion in the late summer and early fall of 1991 to address the complex issue of inter-regional connectivity. Specifically, FARNET considered future options for the provision of connectivity among midlevel networks after the current agreement for NSFNET backbone services expires in November, 1992. Participants included representatives from FARNET member networks, other NREN stake holders (including telecommunications carriers and leaders in university information technology), Federal agency representatives, and legal and economic experts. Our report was well received by NSF. In fact, several key concepts from the FARNET report regarding network stability and multiple awards to inter-regional connectivity service providers were included in NSF's report to the National Science Board, "Project Development Plan: Continuation and Enhancement of NSFNET Backbone Services." (A copy of FARNET's Recommendations to the National Science Foundation Regarding Inter-regional Connectivity is attached.)

"More specifically, will the plan lead to a level playing field for the commercial network providers?"

In their report to the National Science Board, "Project Development Plan: Continuation and Enhancement of NSFNET Backbone Services," NSF identified the two seminal issues associated with the recompetition process: preservation of network stability and promotion of competition. Regarding fair competition, NSF's report further identifies two essential points: that the incumbent provider is not favored, and that equal opportunity is provided to other firms desiring to participate in the provision of transcontinental TCP/IP networking services.

To facilitate the accomplishment of these objectives, the NREN Engineering Group (NEG) advising the National Science Foundation has proposed clear separation of the administration of network routing from the provision of transcontinental circuits and digital switching fabric. Operationally, this separation will be achieved through two independent solicitations. The NEG has recommended that the solicitation providing for the formation of an Internet Routing Authority (IRA) be awarded to a single entity. FARNET agrees that this single award is necessary to ensure the continued operational viability of the network. The solicitation for connectivity services will include the possibility for multiple awards. FARNET agrees and has strongly recommended that the provision of connectivity services be awarded to at least two competing providers. Thus all awardees will have appropriate incentives to cooperate with each other in the development and operation of interconnection facilities.

If implemented as outlined in the report to the National Science Board, the NSF plan for recompetition of the award for operation of the NSFNET backbone will indeed level the playing field for the commercial network providers while preserving an acceptable level of stability.

"Are there better alternatives to the proposed plan?"

The plan as presented in NSF's report to the National Science Board, "Project Development Plan: Continuation and Enhancement of NSFNET Backbone Services," is consistent with the consensus position of a majority of FARNET's constituency. FARNET endorses the plan as presented, but must again emphasize the importance of multiple awards for the provision of inter-regional connectivity services.

"What are your views on the key issues Congress needs to consider to help ensure a successful evolution of the current Internet to the NREN? What is your vision for the NREN and how would you define the roles of the public and private sectors in realizing that vision? What specific steps should be taken by the Congress and the Federal agencies to help ensure the goals for the NREN are achieved?"

Something significant is happening in our country. Over the past five years under NSF's leadership, America has made great progress toward creating a national data communications and information infrastructure to enable research, education, technology transfer, and economic development. This national resource is already delivering material benefit to research and education, both in the public and private sectors. Fully realized, the NREN holds the promise of significantly enhancing our national competitiveness in the global marketplace.

Over the past five years, the Federal Government has played a pivotal role in the creation, growth, and evolution of the NSFNET. Continued Federal investments in the NREN must be focused to ensure equal and ubiquitous access to our nation's information resources, to improve network reliability, performance, and usability, and to enable research in new and pre-competitive technologies. With judicious investments and the correct partnership among government, academia, and industry, we can realize the NREN vision.

FARNET endorses the right of equal access to our nation's information resources.

The NREN has the potential to reduce traditional impediments to data communication and access to information systems: geographic isolation, smallness of size, and sparseness of local resources. Through the NSFNET this vision has become reality for our research and higher education communities interested in information exploration. From small town doctors collaborating with inner city clinicians on a difficult diagnosis, to patrons of a community library wishing to broaden their understanding of the world around them, the NREN can begin to deliver on this promise by funding programs aimed at enabling these previously disenfranchised communities.

Through the NREN, this vision can become reality for all Americans. The benefits provided by the NREN are not restricted to those who are resource poor, but are shared equally by stewards of unique resources. For example, the Smithsonian Astrophysical Center's collection of astronomical images in Boston and the globally distributed antennas of the National Radio Astronomy Observatory are equally accessible to scholars through the NSFNET. The evolution of the NREN must be guided by the principle of equality of access to scholarly information for all Americans.

There is considerable historical precedent for Federal leadership in supporting the creation, operation, and maintenance of the nation's commerce, transportation, and utility systems. In that spirit, FARNET recommends that Congress continue to support the extension of basic connectivity services to underserved and geographically remote communities through the programs of the Federal agencies participating in the NREN.

FARNET endorses the principles of ubiquitous access to and universal interconnectivity of our nation's information resources.

The strength of the Internet, the system of networks that includes the NSFNET, is its broad interconnectivity. Internet technology is now widely employed to electronically link computers -- from microcomputers to supercomputers. These computers can be located within an organization at a single site or within multiple organizations at opposite ends of the country.

We are well on the way to creating a national, and in the near future, even global, communication and information network. Any decision that limits interconnectivity among segments of the Internet impedes the development and reduces the usefulness of this national resource. Educators, researchers, and students must have access to the full array of computing and information resources on the Internet. Balkanization of the Internet cannot be tolerated. Congress must discourage funding policies which allow procurement of network services from disjoint islands of service providers. Endorsing procurement criteria that require the service providers to guarantee interconnectivity to other service providers will ensure that we progress toward a national data communications fabric that reaches every campus, every library, every school, every home.

FARNET endorses continued efforts to improve the reliability, performance, and usability of the networking infrastructure.

Continuing enhancements of network capacity and performance, and improvements in network operations and engineering practices are essential to the development of a reliable and robust NREN. Providing an adequate level of stability and predictability, both in the operation of the current Internet and in the transition to new technologies or management paradigms, is critical to the continuing growth and use of the NREN. Until these advances in network capacity and performance occur as a natural consequences of private sector activity, judicious Federal investments in the nation's communications infrastructure will be required. The continued investment of Federal funds will ensure that major segments of our population (i.e., remote areas, underserved communities, disadvantaged constituencies) are not disenfranchised from this national resource.

Greatly improved support for user and information services network-wide will enable the rapid extension, acceptance, and use of the NREN. This support should include plans for the provision of access to both public and private information resources, with early resolution of copyright and other intellectual property issues. Federal investment in research and development of directory services, network navigation tools, user documentation, and training services is a necessary prerequisite to enhancing network usability.

FARNET endorses the elimination of restrictions on the delivery of commercial services across the NSFNET and the emerging NREN.

We have reached a crossroads in the evolution of true network interconnectivity for our country. The network infrastructure that we are building has the inherent capability to promote research, education, technology transfer, and economic development. Yet, the current acceptable use restrictions on the Federally sponsored national backbone impede our progress.

Close collaboration, even partnership, among government, academia, and industry is essential in promoting the advancement of these critical technologies. Such collaborative efforts are enabled when all partners can, without restriction, access common infrastructure. Yet, current policies prohibit the use of the Federally funded network for commercial purposes. It is as if we were required to have two telephones on every desk, one for making purely "educational" calls and the second for making "commercial" calls. The economic inefficiencies and practical disadvantages of such a system are apparent. If the NREN is to realize its full potential, part of its evolution must include controlled experimentation permitting interconnection of the public and private sectors to achieve a "critical mass" of network users and suppliers.

To remedy the current limitations on interconnectivity between the public and private sectors, FARNET requests that Congress act to remove the current acceptable use restrictions on the Federally sponsored national network infrastructure. At a minimum, commercial traffic should be permitted on this infrastructure on an experimental basis and under suitably controlled conditions. This experiment should be designed to produce results which can be analyzed from multiple perspectives (i.e., technical, administrative, economic, and legal) and should be widely disseminated as envisioned in the High Performance Computing and Communications (HPCC) legislation.

FARNET endorses the principle of inter-agency cooperation and collaboration in the construction of the NREN.

As noted earlier, one of the great strengths of today's Internet is the provision of broad interconnectivity. Although this interconnectivity includes the current NSFNET and the national mission agency networks operated by the Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), and the Defense Advanced Research Projects Agency (DARPA), today's Internet can not be characterized as a single, homogeneous entity. With such a broad and varied constituency, the Interim Interagency NREN is unlikely to evolve as a single, homogeneous initiative, at least in the short term. Yet insofar as existing technologies and current deployment strategies are sufficient to adequately support mission agency activities, the Federal agencies must be encouraged to collaborate and cooperate to reduce costs and to promote the public good.

FARNET endorses further research into key technologies.

The nation must have focused research programs pushing the envelope of high performance production networking. Continued Federal support for basic research is essential to the solution of difficult problems that remain in several critical areas (e.g., network security, authentication, privacy, routing and addressing, high speed circuit and switching architectures).

Forging the appropriate mix of private investment and public sponsorship is critical to the continuing development and delivery of this important technology. Continued Federal investments in these key research areas will leverage private funds and enable the transfer of pre-competitive technologies from academic and government laboratories to private industry.

FARNET endorses the continued close collaboration among government, academia, and industry to realize the NREN vision.

Ten years ago, the Internet was a government-funded research project. Today, internetworking is a multi-billion dollar industry.

Ten years ago, access to this technology was limited to a small cadre of experts in computer science and telecommunications engineering. Today, an estimated 5 million researchers and educators, teachers and students, authors and librarians, physicians and clinicians, policy makers and corporate planners use the worldwide Internet.

Ten years ago, Internet devices were the constructs of research labs. Today, Internetworking hardware and software components are commercially available from a variety of vendors at commodity prices.

Ten years ago, telecommunications providers were offering dedicated digital services within and between only a few metropolitan areas. Today, every major provider offers, or has immediate plans to offer tariffed, high speed packetized digital services aimed at a burgeoning data networking market.

From these achievements it is clear that we have made considerable progress along the sometimes bumpy road toward commercialization and privatization of the Internet. The components of networking technology have matured and become available commercially. Prices of networking equipment, circuits, and services have dropped for all consumers. New vendors with new capital have been attracted into the market, creating new high-technology jobs and opportunities.

But the internetworking industry faces the classical set of challenges associated with success management. While business activity in the private sector grows, we must avoid the temptation to reduce government investment in new or pre-competitive technologies. While the costs of connectivity in our metropolitan areas continue to decrease, we must avoid the temptation to reduce government support for communities that are underserved.

If we move cautiously forward in the correct partnership of government, academia, and industry, our nation can work together to realize the NREN vision.

We trust that these observations will be of use to the Subcommittee in its March deliberations. These comments are respectfully submitted by Dr. Eric S. Hood, President of the Federation of American Research Networks (FARNET).

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Recommendations

to the National Science Foundation
from the Board of FARNET, Inc.
Regarding Inter-midlevel Connectivity
after the Expiration of the
Current NSFNET Backbone Agreement

Introduction

With support from the National Science Foundation, FARNET (the Federation of American Research Networks) conducted a workshop and electronic discussion in the late summer and early fall of 1991 on the question of how connectivity among midlevel networks should be implemented after the current agreement for NSFNET backbone services expires in November, 1992. Participants included representatives from FARNET member networks, other NSFNET stakeholders (including carriers and leaders in university information technology), Federal agency representatives, and legal and economic experts. We gratefully acknowledge the participation of all those who helped to make this a fruitful and instructive process. As a result of this extended dialogue, the FARNET Board is pleased to make the following comments and recommendations to the National Science Foundation.

Section I CONTEXT: The NREN, the NSFNET Backbone, and the Midlevel Networks

In November, 1992 a five-year agreement between MERIT, Inc. and the National Science Foundation for the operation of a national backbone network for the NSFNET will expire. Viewed from almost any perspective, the pace of activity in the networking arena since 1987 has been astonishing. Network traffic has grown exponentially; bandwidth has increased by a factor of nearly 700; the number of networks connected to the backbone has increased from a few hundred to more than 3,000; and the user population is now estimated at more than 2,000,000 people nationwide.

In addition, Congress and the Executive Branch, with a level of support from higher education and industry that is remarkable, have created a cohesive High Performance Computing and Communications program. A key component of this program, which is designed to push the frontiers of computer communication technology and maintain a U.S. leadership position in high performance computing, is the construction of a National Research and Education Network (NREN). According to the Office of Science and Technology Policy[1], NSF is expected to coordinate the "harmonization of existing agency networks" into the NREN and to support research into high-speed protocols, switches, and other technology.

Because of the extraordinary growth of the NSFNET and the visibility of the HPCC program in government, industry, and academia, the next generation of the network (the "interim interagency NREN," or IINREN) will be developed and deployed in an environment very different from that of the mid 1980s.

The NREN user community now includes many Federal agencies, libraries, hospitals and health care professionals, and a growing number of educators at the elementary and high-school levels. The list of stakeholders includes the RBOCs, the interexchange carriers (the three largest of whom now have operational roles in the NSFNET), several resellers of value-added network services (such as ANS, Alternet, and PSI), more than 25 state and regional networks, many publishers and others in the commercial information industry, and virtually all of the companies that supply the telecommunications industry with equipment.

At the same time, the pressures for commercial use of the backbone facilities, from both potential consumers and potential providers, are tremendous. Vendors are clamoring to deliver software, technical support, instruction, news, and information across the network, and buyers are ready to purchase. But the market for network-based services is immature, in part because the value of such services is not well understood and also because restrictions on the commercial use of government-sponsored networks have discouraged such use.

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[1] *Grand Challenges: High Performance Computing and Communications.* The FY 1992 U.S. Research and Development Program. A Report by the Committee on Physical, Mathematical, and Engineering Sciences, Federal Coordinating Council for Science, Engineering, and Technology, Office of Science and Technology Policy.

Because of this immaturity, and in view of the ambitious goals of the NREN program, a completely market-driven approach to the evolution of the network at this time is widely viewed among FARNET members as unlikely to satisfy some of the most important desiderata described below.

Section II DESIDERATA: Critical Factors in the Evolution of the NSFNET to the Interim NREN

FARNET members believe that the following are the critical issues surrounding the continued development of the NSFNET:

- Establishing a strong Federal NREN program, which will leverage significant private investment in the next generation of the network and will attract state and local funding and use

- Maintaining or improving U.S. technology leadership in the areas of high performance computing and communications, and developing strong mechanisms for technology transfer

- Providing an adequate level of stability and predictability, both in the operation of the network and in any transition to new technology or management structures, with particular emphasis on the requirements of the mission agencies (NASA and the Department of Energy)

- Greatly improving support for user and information services network-wide, including access to both public and private information resources, with early resolution of copyright and other intellectual property issues

- Ensuring adequate levels of performance, which will require that more attention be directed to network management, routing arbitration, cross-connect mechanisms, monitoring and problem resolution tools and procedures, etc.

- Offering a variety of choices for state and regional networks in backbone services (providers, location, access speeds, technologies, costs, etc.)

- Rapid elimination of restrictions on delivery of commercial services across the network, and structured transition to commercial provision of network systems and services

- Availability of widespread and equitable access to the network at reasonable cost, with a minimum level of guaranteed interconnectivity among service providers

- Providing mechanisms to ensure global interconnectivity without undue restrictions

Section III RECOMMENDATIONS: FARNET Recommendations to NSF Regarding Inter-midlevel Connectivity in the Interim NREN

1. The multi-tier model for providing network services is valid and should be preserved.

Experience confirms the validity of the three-tier approach (backbone, midlevel networks, and campus networks) that NSF adopted in the mid-80s. The vibrant infrastructure of state, regional, national, commercial, and non-profit providers that has been created around the NSFNET backbone since 1986 is the best argument for this approach.

Regional and state networks have been able to leverage resources, both public and private, that may not have been available (or even apparent) to a national organization. The multiplicity of providers has generated considerable innovation in services and products and has increased the number of knowledgeable and committed network experts. We do not believe that the NSFNET could have expanded as rapidly and successfully as it has without strong local and regional involvement. At the same time, the network has profited from ambitious and successful efforts by Merit, IBM, and MCI (and now ANS) in establishing the NSFNET backbone.

We expect that the structure of the IINREN will continue to evolve and change as current providers reassess their missions and new providers emerge.

For example, we are not sure that future connections between midlevels will necessarily be of the type we have today, with dedicated private lines linking centrally managed routers. Other emerging topologies deserve consideration, including CIX/FIX-like structures (shared FDDI-based interconnection points) and shared use of national cell relay or frame relay networks.

For convenience, in this paper we will refer to both traditional backbones and the use of alternate topologies in the top level of the three-tier hierarchy as "top-level backbone services."

2. Strong NSF support for top-level backbone services must continue.

NSF must continue to provide strong support for the development of the top level of the IINREN, including support for robust and capable backbone services. As called for in the HPCC program, this should include funding for higher-level applications and user support, as well as new protocols, switch and transmission technologies, and higher bandwidth. In addition, all targeted users should have access to the IINREN at appropriate bandwidths, to be determined in conjunction with users and midlevel providers.

NSF has provided critical leadership for the NSFNET backbone and seed funding for the midlevel networks, as well as support for the connection of hundreds of campuses to the network. Its actions, particularly in the backbone arena, have galvanized the response of industry. We expect that continued NSF support for top-level services will preserve this important leveraging effect.

3. As the agency responsible for NREN facilities coordination and deployment under the HPCC plan, NSF must assume a strong management role *vis a vis* the core of the NREN (which presumably will evolve from the current NSFNET).

We believe that NSF is well qualified to be the lead agency in this area. Its leadership is committed to the HPCC program. It has established excellent relationships with industry and higher education, both in the NSFNET program and in the gigabits research program. It has demonstrated vision and skill in executing these programs.

During the next phase of development, NSF will need to take an assertive position *vis a vis* the management and oversight of the backbone if it is to meet the NREN/HPCC goals as established by Congress and the Executive Branch. This is true whether there is a single, or multiple, providers of backbone service. In particular, NSF must play a proactive role to accelerate the harmonizing of multiple agency networks and protocols into a single shared NREN.

4. The operation of the backbone network should be recompeted in the GFY92 timeframe with multiple awardees.

As described earlier, many conditions have changed since 1987, when the current agreement for backbone operations was made. In view of these changes and of the emergence of the HPCC program, we recommend that NSF issue a new solicitation for the provision and operation of production quality midlevel interconnection services. A variety of approaches would be encouraged and evaluated through peer review. The new providers would begin service in GFY93.

The award should include at least two service providers who would be required to cooperate in the delivery of services, with specific attention to the resolution of administrative, legal, technical, and pricing issues associated with interconnection of facilities operated by different vendors. The goal is to promote neutrality at these cross connects. Experiments with pricing, transition to commercial services, etc. should be conducted as part of the operation of the network.

The redesign of the backbone should be based on engineering and economic criteria. That is, the topology and capacity of the network should be derived from the distribution and usage patterns of the target population (existing and projected), and the design should make efficient use of existing and planned carrier facilities.

The establishment of NSF-supported multi-provider backbone services will encourage the development of market mechanisms to ensure performance and enhance competition among providers and will lead more rapidly to a structured transition to commercial provision of network systems and services.

5. NSF should ensure that new technology is deployed in the backbone very carefully, to protect the quality of service to the end-user.

Because hundreds of thousands of users already rely on the NSFNET for day-to-day support of research and educational activities, it is clear that we require a production-quality network today. The service level should approach the same standards as we used to expect from voice service.

This means that the network operators must introduce new technology very carefully into the backbone, balancing the need for improvement with the need to maintain production-quality service. To keep pace with technical changes and demand for new services, they will have to upgrade facilities and equipment. At the same time, they must be held to clear performance standards. NSF should develop those standards in cooperation with the user community (per Recommendation 8, below) and should enforce them as part of its oversight function.

6. Midlevel networks should be able to exercise choice among vendors of top-level backbone services.

To further the development of the market for commercially provided network services, midlevel networks should be able to exercise choice among providers. Mechanisms to allow choice by midlevel networks of a production backbone awardee could be implemented in a variety of ways, ranging from direct funding of the midlevels for that purpose to designation of a preferred awardee by the midlevel with NSF funds flowing directly to the backbone operators.

7. The backbone awardees should not be able to take advantage of their position to inhibit competition or to compete unfairly.

Because the provision of reliable top-level services is essential to the success of the IINREN and the entire HPCC program, we emphasize again that NSF should maintain a strong, central oversight role in the provision of these services. Oversight should include both technical and management issues. In particular, NSF should guard that the winners of any new backbone solicitation do not use their position to inhibit competition or compete unfairly.

8. Provider accountability for performance should be ensured through the NSF award process.

All organizations that receive NSF funding for the delivery of network services, from the campus level through the midlevels to the top level, must be held to clear performance criteria. These should be established by NSF in concert with the users and the providers of the service. The criteria must be objective and measurable and should be designed to ensure an acceptable level of service end-to-end throughout the IINREN.[2] Reliability and availability should be emphasized. Where the tools and systems to measure performance and resolve network outages are inadequate, NSF should provide funding to develop improved versions.

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[2] This recommendation evolved from a discussion of possible "certification" of network service providers. The goal of the certification process was the establishment and enforcement of minimum performance requirements across the network. We felt that implementing the requirements via NSF's award criteria and existing review process would be more direct and less bureaucratic.

9. NSF should take a leadership role in developing mechanisms to permit commercial traffic to be carried on the IINREN.

In the FCCSET report on "Grand Challenges," NSF is assigned the task of "initiating the exploration of pricing mechanisms for network service and network applications and structured transition to commercial service." NSF should actively promote and provide explicit guidance for this transition. To the extent that this requires research into legal or policy issues, or into techniques for performing accounting functions, NSF should support such research. In particular, it is most desirable from our point of view that the interim NREN be used in part for the delivery of commercial information and other services.

The number of commercial companies already involved in the operation of IP-based computer communication networks -- including US Sprint, AT&T, MCI, PSI, ANS CO+RE Services, and Infonet -- along with developments such as the emergence of CIX, Inc. (the commercial Internet exchange) indicate that commercial vendors are already alert to the possibilities that the NREN program offers. The emergence of a larger market for network connectivity and services and the entry of new providers will, in the long run, lead to lower prices for all consumers as the marginal cost of delivering services diminishes and economies of scale come into play. Moreover, this expanded market will attract additional investment by commercial companies since it offers greater potential returns on investment. Additional investment will lead, in turn, to more rapid technology development. Coupled with the explosive growth in business use of IP-based networks, the NREN program in the public sector can help to drive the commercialization of wide-area network technology much as the NSFNET program has.

10. NSF should explore the feasibility of connecting midlevel networks using a FIX or CIX model as an alternative to a traditional backbone. Direct inter-regional links may also be desirable when such direct links reduce costs and/or improve reliability.

NSF should explore the feasibility of linking midlevel networks using a FIX or CIX interconnect model as an alternative to a traditional backbone. Furthermore, NSF should seriously entertain proposals based on direct inter-regional links where such links can reduce costs and/or increase the end-to-end reliability and redundancy of the IINREN.

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11. NSF should support the development of software tools for end-user applications and network management and operations.

NSF should issue one or more solicitations for the development and deployment of tools for network management and operations, end-user applications, routing protocols, etc. Practical solutions to existing problems should be emphasized. For example, we believe that the lack of useful tools for information retrieval and display is one of the biggest impediments to the productive use of the network and has impaired the credibility of the NREN in the eyes of the target user populations.

NSF should consider the issuance of several separate solicitations for for the development of software tools to ensure that this area is given adequate attention. Operators of NSF-supported networks should work closely with the awardees to ensure the rapid testing and deployment of new software tools.

NSF should continue to emphasize open architectures and standards in these solicitations. Its early decision to specify TCP/IP as the standard networking protocol for the NSFNET was a profoundly effective incentive for the extension of networking services. Where standards are not adequately understood or developed, NSF should support programs to test, evaluate and improve them.

12. NSF should issue a new solicitation aimed at midlevel and campus providers, with award criteria based on policy goals such as improving the ease of use of the network and leveraging private and non-Federal public funds.

Finally, we recommend that NSF, working with the user community and the providers, define and implement clear criteria for the award of additional funding to midlevel and campus networks (as distinct from the top level) and issue a new solicitation in this area. In the early stages of the deployment of NSFNET, this funding was appropriately focused on "connectivity." The new criteria should be designed to further specific programmatic and policy goals such as the extension of network services to new or underserved communities (for ubiquity), the improvement of network operations procedures and tools (for reliability), the enhancement of existing services through development activities, upgrading of existing connections to "have-not" institutions, leveraging of state, local, and private funds (to maximize the impact of Federal investment), training and support for end-users (in cooperation with national and local programs), etc.

FARNET Workshop on Inter-regional Connectivity

August 12-13, 1991

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Bridger Mitchell, The Rand Corporation
Michael Roberts, EDUCOM
George Strawn, National Science Foundation
Richard West, University of California System
Stephen Wolff, National Science Foundation

Dr. Eric S. Hood

Executive Director
NorthWestNet

Dr. Eric S. Hood is the Executive Director and Principal Investigator of NorthWestNet, a regional computing and digital communications network serving the six states of Alaska, Washington, Oregon, Idaho, Montana and North Dakota. Dr. Hood also serves as President of the Federation for American Research Networks (FARNET) and as a member of the Regional Networking Advisory Council of Advanced Networks and Services, Inc. (ANS).

Before joining NorthWestNet in June 1991, Dr. Hood had served for four years as Director of Systems and Computing Services at Montana State University with responsibility for university computing, networking, information systems and telecommunications. During his last two years at Montana State, Dr. Hood also served concurrently as the Executive Director of the Montana University System Education Network (MUSEnet), a digital communications network linking all six campuses of the Montana University System and the Office of the Commissioner of Higher Education.

In 1983 Dr. Hood received his doctoral degree in Theoretical Chemistry from the University of California at Santa Barbara (UCSB). From 1983 through 1985 Dr. Hood was a Bantrell Fellow of Chemical Physics and Chemical Engineering at the California Institute of Technology (CalTech). Dr. Hood has also held the positions of Regents Fellow of the University of California and Visiting Scientist at the IBM Thomas J. Watson Research Center in Yorktown Heights, New York. Prior to entering the field of computing and network management, Dr. Hood held the position of Assistant Professor of Chemistry and Physics at Montana State University.

Dr. Hood has published several dozen scientific and technical papers in the fields of material science, theoretical chemistry, surface physics, computing and networking. Dr. Hood's research and development programs have received grant support from the National Science Foundation, the Department of Energy, the Department of Education, Digital Equipment Corporation, and Zenith Data Systems.

Mr. **Boucher**. Thank you, Dr. Hood.

Mr. Kaptor.

Mr. **Kapor**. Mr. Chairman, members of the subcommittee, thank you very much for the opportunity to testify.

My name is Mitchell Kapor, and I'm here today in two capacities: as president of the Electronic Frontier Foundation, which is a public interest advocacy organization promoting the democratic potential of new computer and communications technologies, and as chairman of the Commercial Internet Exchange, or CIX, a trade association of commercial internet working carriers which represents a substantial fraction of the carriers serving the internet, and, as you may know, I'm also the founder of Lotus Development Corporation and the developer of Lotus 1-2-3, both of which have played a seminal role in the emergence of the personal computer industry.

To frame my remarks, let me begin by saying we fully support the NREN legislation designed to develop computer networks linking research and education institutions, Government, and industry, and among the chief goals are expanding the number of users on the network, avoiding creation of information haves and have-nots, providing enhanced access to electronic information resources, supporting the free flow of ideas, and promoting research and development for the purpose of developing commercial data communications.

The internet, as it evolves into the NREN, serves as a vital test bed for the eventual development of ubiquitous national public networking. So in that context the problems I am about to address which exist today should really be seen as the normal growth pains of an experiment which, as you have heard, has already succeeded far beyond the wildest imagination of its creators.

Three problems, one minute each. Problem number one: The NSF-imposed acceptable use policy is hindering the development of information services which would serve the research and education community as well as others. Acceptable Use Policy, or AUP, attempts to define limitations on the types of traffic which can flow on the network.

However, you should know there is no agreement in practice about how to apply the AUP, and, in fact, businesses which might wish to operate on the net to provide services are reluctant to do so because they perceive an atmosphere of uncertainty and of restriction and do not want to proceed until this is clarified, and this is preventing users on campuses from doing things like ordering technical books and journals from on-line vendors and from consulting on-line commercial data bases to aid in their research.

There have been some tentative and experimental steps in this direction, but they are very, very far away from the free and open entry of commercial service providers which we think should happen. There needs to be a stable climate, and we believe the NSF ought to modify or drop the AUP to permit information innovation services.

Problem number two: The current arrangements between NSF, Merit, and ANS, while extremely well intentioned, have created a tilt in the competitive playing field. ANS enjoys certain exclusive rights through its relationship with NSF to carry commercial traffic across the NSFNET. I'm sure the question and answer period will be a lively one if we pursue this topic. This has introduced significant marketplace distortions in the ability of other, private carriers to compete for business, and you will hear about that in a moment from Mr. Schrader.

We believe the science board should be directed to reconsider its decision to extend the current Merit-ANS arrangement by up to an additional 18 months. The arrangement by which ANS simultaneously provides network services for NSF and operates its own commercial network over the same facility must be brought to an orderly but rapid close in order to permit free and fair competition.

Problem three: The current basic approaches to funding of network services by NSF and to the network architecture as a whole, while they have been extraordinarily successful in bringing us to the current point, have ceased to be the most efficient and most appropriate methodologies, and the time has come to begin to move on.

The historical and current funding model has been to subsidize network providers at the national and regional level. We need to move to a situation in which the individual education and research institutions receive funding through which they purchase network services which are provided in the private sector.

And, similarly, while we have had in terms of network architecture a centralized, subsidized backbone network, we no longer need this for the day-to-day production network which serves the overwhelming majority of users of the system. Instead, we should move to a system of interconnected private carriers of national scope. Note that I am not referring to appropriate Federal investments and subsidization of precompetitive, experimental, ultra-high-speed networks.

If industry knows that there is an open and fair opportunity to compete to provide network connections and services to the research and education community, it will supply as much T-1 and T-3 connectivity as is needed more cheaply, more efficiently, and more reliably through any other method.

Thank you very much.

[The prepared statement of Mr. Kapor follows:]

Testimony of

Mitchell Kapor

President, Electronic Frontier Foundation
and
Chairman, Commercial Internet Exchange

before the

United States House of Representatives
Committee on Science, Space, and Technology
Subcommittee on Science

Hearing on the Management and Operation
of the NSFNET by the National Science Foundation

March 12, 1992

Mr. Chairman:

My name is Mitchell Kapor. I want to thank you for inviting me to present my views on the importance of research and education networks, and the beneficial role that commercial forces can play in this arena. At your request, I come before this Committee in two capacities. As the President of the Electronic Frontier Foundation, a public interest advocacy organization concerned about promoting the democratic potential of new computer and communications technologies, I hope to offer a vision of how the National Research and Education Network (NREN) can enhance research and educational opportunity for an ever-growing community of users. As the Chairman of the Commercial Internet Exchange, a trade association that promotes the commercial Internet market, I will give some suggestions on ways that Congress can help to eliminate some of the current impediments which unnecessarily limit entrepreneurial innovation in the Internet arena.

For those who may not know me, I am also the principal developer of the Lotus 1-2-3 spreadsheet program and served as the CEO of the Lotus Development Corporation between 1982 and 1986 during which time it grew into a $200 million dollar a year software company.

I believe that Congress, and this Committee in particular, has a vital role to play in:

•ensuring that NREN services reach the broadest possible community of users;

•creating an environment which stimulates the development of new network technologies and applications, and;

- leveraging federal involvement with private sector cooperation.

Again, thank you for the opportunity to participate in this process.

I. Background

A. The Electronic Frontier Foundation

The Electronic Frontier Foundation (EFF) was founded on a shared conviction that a new public interest advocacy organization was needed to educate the public about the democratic potential of new computer and communications technologies and to work to develop and implement public policies to maximize civil liberties and competitiveness in the electronic social environments being created by new computer and communications technologies. Our primary mission is to insure that the new electronic highways emerging from the convergence of telephone, cable, broadcast, and other communications technologies enhance First and Fourth Amendment rights, encourage new entrepreneurial activity, and are open and accessible to all segments of society.

The EFF is committed to ensuring that the rules, regulations, and laws being applied to emerging communications technologies are in keeping with our society's highest traditions of the free and open flow of ideas and information while protecting personal privacy.

B. The Commercial Internet Exchange

The Commercial Internet Exchange Association (CIX) was formed in 1991 as a trade association open to all commercial Internet carriers. All members agree to exchange traffic at a fixed and equal cost set by the association. The primary goal is to provide connectivity among cooperating carriers, with no restrictions on the type of traffic allowed.

Today, there are seven CIX members with both domestic and international networks: BARRnet, CERFnet, EUNet, Performance Systems International (PSI), Unipalm Limited, UUNET Technologies, and US Sprint. Over 3000 commercial firms can be reached through the CIX member networks, with no restrictions on use. The top 20 computer companies in the US are all connected via the CIX, and many are delivering commercial support services (e.g., software/hardware and consulting) over it.

The CIX is structured to grow and migrate with the emerging needs of the commercial Internet. Many multinational carriers and at least three dozen regional networks in the US, Europe, and Japan have expressed interest in joining. In response to this interest, the CIX membership has developed plans to improve network technology support services that benefit the entire community. The CIX will also actively encourage new services on the commercial Internet.

II. Visions of the NREN

The NREN is intended to "link research and educational institutions, government, and industry, in every State,"[1] together. Agencies responsible for implementing the NREN "shall work with State and local agencies, libraries, educational institutions and organizations, and provide network service providers in order to ensure that researchers, educators, and students have access to the Network." The NREN will not be created out of thin air.

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[1] High Performance Computing Act, Pub. L. No. 102-194, 105 Stat. 1594 (1991) ("HPCA"), Sec. 5(a)

Rather, it is an expansion of the Internet, a twenty-year old international network that links over three million users in 30 countries. The Internet is a vital part of the interim NREN.

Wearing my Electronic Frontier Foundation hat, I believe that this committee should take a broad view of the possibilities of an NREN that reaches into all levels of schools, libraries, hospitals, community centers, and even homes. These are some goals that the Committee should strive for in its long-term NREN implementation plans:[2]

A. Expand the number of users who have access to the Internet and NREN

The tremendous popularity of the Internet has already demonstrated the value of public data networks among higher eduction and research institutions. Congress should adopt policies which help make Internet resources accessible to an ever-broadening community of users. In the 1960s, the average fifth grader had no need to use the ARPANET to access remote computing power. But in the 1990s, students down to the elementary school level can benefit from having access to libraries and other on-line educational resources from all around the country.

As information technology becomes more and more sophisticated, some have warned that we could be dividing American society into the "information haves and havenots." Let us use the NREN as one of many

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[2] See also, M. Kapor & J. Berman, "Building the Open Road: The NREN As Test-Bed For The National Public Network," in *Building Information Infrastructure: Issues in the Development of the National Research and Education Network*, 1992 (B. Kahin, ed., McGraw-Hill)

tools to enable all segments of society to have access to important information and communication resources.

B. Enhance "access to electronic information resources maintained by libraries, research facilities, publishers, and affiliated organizations."[3]

Millions of scientists, students, government workers, and even the occasional Congressional staffer rely on the Internet as a primary computer and communications tool. Researchers exchange scientific information, students further their education, government workers communicate with others working on publicly-funded projects, and some of us even use the Internet to stay in touch with political developments.

The more information that is accessible over the Internet, the greater its value to its users, but the potential of the Internet as an information dissemination medium for both public and private institutions has only just begun to be explored. Congressional policies that allow both non-commercial and commercial information providers to offer their services over the NREN will enhance the productivity and creativity of researchers, educators, students, and other NREN users.

C. Support the free flow of ideas

The academic community relies on the Internet as a forum for exchanging scholarly research and data. So, traditional academic freedom of speech, as guaranteed by the First Amendment, should be protected in this new forum.

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[3] HPCA, Sec. 5(e)

D. Promote "research and development leading to commercial data communications and telecommunications standards."[4]

The HPCA recognizes two important areas of research for the development of the NREN. First, much basic engineering work remains to be done in order to provide the high-speed (gigabit) data transmission services required by certain applications, such as supercomputing and high definition video and graphics. Second, in order to bring the benefits of network information services to a wider community of users, standards for data presentation and access need to be developed. For example, because most libraries catalog books according to standard systems which we have all been taught, we can walk into almost any library and find the books we need. If electronic information services are to be truly useful beyond a narrow group of technical workers, much progress must be made toward making the services easy to use.

E. The NREN as a Testbed

In enacting the NREN legislation, the Congress is taking a critical step toward what I call the National Public Network, the vast web of information links organically evolving from computer and telephone systems. By the end of the next decade, these links will connect nearly all homes and businesses in the U.S. They will serve as the main channels for commerce, learning, education, and entertainment in our society. The new information infrastructure will not be created in a single step: neither by a massive infusion of public funds, nor with the private capital of a few tycoons, such as those who built the railroads. Rather the national, public broadband digital network will emerge from the "convergence" of the public telephone network, the cable television distribution system, and other networks such as the NREN.

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[4] HPCA, Sec. 5(d)(2)

Not only will the NREN meet the computer and communication needs of scientists, researchers, and educators, but also, if properly implemented, it could demonstrate how a public information network can be used in the future. As policy makers debate the role of the public telephone and other existing information networks in the nation's information infrastructure, the NREN can serve as a working test-bed for new technologies, applications, and governing policies that will ultimately shape the larger national network.[5] So, as the Committee acts to implement the NREN, I urge you to remember that the patterns set by pioneering networks such as this will play a critical role in shaping the Nation's information infrastructure.

III. Recommendations for Transition to Full Commercial Operation

In passing the High Performance Computing Act, Congress provided a clear set of goals for the NREN and guidance on how to achieve those goals. This Committee and the entire Congress have made it clear that the Network services should be provided in a "manner which fosters and maintains competition within the telecommunications industry and promotes the development of interconnected high-speed data networks by the private sector."[6]

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[5] The NREN "would provide American researchers and educators with the computer and information resources they need while demonstrating how advanced computers, high-speed networks, and electronic data bases can improve the national information infrastructure for use by all Americans." HPCA, Sec 2(a)(6)

Under the NSF's management, the use of the Internet by commercial organizations has been wildly successful. Nearly 60 percent of all registered computing sites on the Internet are commercial organizations. Within two years this number is expected to grow to nearly 90 percent. It is not surprising, in light of this rapid change in the Internet environment, that even with the best intentions on the part of NSF, some problems occurred along the way. I am optimistic that new policies based on a careful look at the market today can create a thriving commercial environment on the Internet.

The task that this Committee begins today is to shape an implementation strategy that achieves these important national goals by carefully examining the recent history of the NSFNET and the rapidly changing structure of the data networking marketplace.

The HPCA sets as a goal that "the Network shall be phased into commercial operation as commercial networks can meet the needs of American researchers and educators."[7] Speaking as Chairman of the Commercial Internet Exchange, I can say with confidence that the commercial Internet providers already in the market can meet the networking needs of current NSFNET users for T1[8] now and will be able to meet the needs for T3[9] services in the very near future. Therefore, I offer the following short- and long-term recommendations for reaching the goal of a fully commercially-operated NREN.

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[6] HPCA, Sec. 5(d)

[7] HPCA, Sec. 5(d)(3)

[8] T1 services have the capacity to transmit data at 1.544 megabits per second.

[9] T3 service carries 45 megabits of data per second.

A. Short Term - Until November 1992

1. Modify the NSF Acceptable Use Policies to encourage the availability of commercial information services and promote competition among carriers.

As part of its current management of the NSFNET backbone, the NSF has set a series of "Acceptable Use Policies" which define the type of traffic that can be carried over the NSFNET backbone. The AUP restriction most relevant to today's hearing requires that all data carried over the NSF backbone be "in support of research and education." This restriction frustrates two important NREN goals by precluding widespread offering of commercial electronic information services, and discouraging commercial organizations from making full use of the Internet.

A brief note about the three-level structure of the Internet may be helpful here. At the lowest level are local networks maintained by each connected institution. Next, mid-level or regional networks connect a number of local networks together. Finally, there are backbones which link regional networks together. The NSFNET is a backbone that connects a number of regional networks and offers interconnection to other government networks and international networks. But other providers, including two CIX members, PSI and Alternet, have their own international backbones which interconnect with several regional networks, commercial organizations, and international networks. Funding for local and region networks comes from a variety of public and private sources, but the NSF backbone is paid for by NSF funds.

As the Internet was growing, the NSF wisely instituted an AUP that allowed for a wide variety of uses of the network, including some that could strictly be classified as "commercial." This open policy encouraged extensive use of the Internet and made it a success. An unfortunate side effect of this openness is that there is substantial confusion about what kind of traffic is allowed and what is forbidden. In practice, electronic mail users can make commercial use of the Internet with impunity because e-mail is private. But the uncertain scope of the AUP discourages many potential commercial users of the Internet from joining the network.

In 1990, an exception to the commercial use restriction in the AUP was created by the NSF. In an agreement between the NSF and Merit, the primary NSFNET backbone contractor, Merit was allowed to subcontract the backbone services to a new non-profit corporation, Advanced Network Services (ANS). ANS in turn created a for-profit subsidiary called ANS CO+RE which now has been given the exclusive right by NSF to sell backbone connections that carry commercial traffic across the NSF sponsored gateways between the T3 backbone and the regional networks. This commercial traffic would otherwise be in violation of the AUP.

NSF and Merit arranged for ANS CO+RE to pay some portion of the cost of carrying the commercial traffic into a fund that is intended to benefit the regional networks connected to the backbone. However, ANS CO+RE is still the only network service provider which has thus far been authorized by NSF to pass commercial traffic over the backbone to regional networks.

Retaining ANS as the only firm that is able to offer commercial access to the NSFNET backbone creates market distortions which impede the commercial expansion of the Internet and limit the scope of services available to future NREN users. When the NSF created the current arrangement, little was known about how the commercial Internet market would develop and the impact NSF's choices would have. In planning for the future, Congress should begin now to take steps to achieve the NREN goals of promoting the development of commercial services and an open, competitive environment.

2. Encourage Cooperative Efforts within the Commercial Internet Industry Which Enhance Interconnection Among Carriers

Since the backbone arrangements that NSF structured did not allow for open routing of commercial Internet traffic, CIX members and ANS have recently begun negotiations to address these problems. Fruitful discussions are underway between the concerned parties with the intent of developing interconnection arrangements that promote the open flow of commercial traffic to all parts of the Internet that are willing to accept it. I hope that this Committee can lend its support to these efforts and set them as a model for voluntary resolution of various industry "growing pains."

3. Find Alternatives to the Current NSFNET Backbone Arrangement with ANS which are Fair to All Parties

The National Science Board should be asked to reconsider its decision to extend the current backbone arrangement for an extra eighteen months past November 1992. This may have appeared to be an easy, natural transition from the NSFNET to the NREN. However, commercial service providers now in the market are fully prepared to offer the services necessary to maintain the existing level of NSFNET service while the higher speed NREN is being built.

In the early history of the Internet, organizations that needed network access relied almost exclusively on connections offered by the Federal sponsors of the Internet. At its birth, when it was known as ARPANET, little was known about how to build large public data networks. Federal research support played a critical role providing network access and in the development of public networking technologies. Because early Federal support was so successful, the Internet operating protocols have been adopted as international standards and are used in data networks across the country and around the world.

As current networking technology has stabilized, many private sector sources -- including members of the CIX -- are now able to offer Internet access as well. By offering low-cost connections and individualized service, private network service providers have made Internet access available to many who do not receive direct government sponsorship. The NREN legislation lays out ambitious plans for development of advanced networking technology, but private providers now have the experience to offer standard Internet services. Therefore, active government involvement in providing network access services can be ended. Furthermore, given the problems already noted, any extension of the current arrangements without a fully competitive selection process would be unwise.

B. Long Term: Find Ways to Phase Out the Current Backbone Structure After November 1992

In the long-run, those agencies responsible for the continuation of the current NSFNET services should seek alternatives to a centrally-controlled backbone. When the upgraded NSFNET of the mid-1980s was experiencing growing pains and performance degradation, building a high speed backbone was a reasonable response on the part of the NSF. The data transmission technology at the heart of the backbone[10] was in experimental stages; so, a government-funded backbone was appropriate to help develop this technology. But now, five years later, the building blocks of the backbone are available "off the shelf" and can easily be interconnected without direct government intervention. Internet connectivity is now a commodity service which can be purchased on the open market just like other carriage services such as long distance telephone service, shipping, air freight, or overnight mail.

Rather than making payments to backbone and regional network providers, the NSF and any other government agencies that have responsibility to connect institutions to the Internet should give the subsidy directly to the target institution. The institution can then take this money and purchase Internet connectivity from a variety of service providers.

As in the long distance telephone market, or the rail service, carriers will have to enter into cooperative agreements to be sure that an Internet customer on one carrier's service can send and receive data from customers on other services. Even with the backbone in existence, a significant amount of inter-regional traffic bypasses the backbone as part of bilateral arrangements between various regional networks. The Internet community has a long established tradition of promoting interconnection, and developing and adhering to international standards. So, there is every reason to believe that this pattern of cooperation will continue.

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[10] T1 and later T3 services.

C. Research Priorities

1. Direct support for development of advanced research network -- the gigabit network envisioned by the NREN

Funds allocated for work on advanced network engineering should be targeted exclusively to the development of high-speed gigabit networking technology. An important part of the NREN will be an experimental, high-speed research network which is capable of sending data many times faster than the current NSFNET. But this new research network should not be confused with the existing "production" network now called the NSFNET. Research dollars should be kept for research networks that will expand our understanding of how to do high-speed networking, not for subsidizing existing network services. Conversely, users who depend on the Internet for routine work should not have the reliability of their services compromised by the inevitable vagaries of a research network under development. The research network should certainly be interconnected with the production network, but their operation and funding should be kept as separate as possible.

2. Stimulate applied development activities

In addition to basic network engineering that increases speed and capacity, some research support should be directed to development of applications that make network easier to use and access for end users. Ease-of-use was not a major concern in the early days of the Internet, since most users had technical backgrounds. But, if we are to meet the goals of the HPCA which seek to make the Network available to a larger class of non-technical researchers and students, efforts to make network services more "user-friendly" are essential. Furthermore, the NREN is an opportunity to create a variety of "test-bed" applications that will help lead the way to more advanced uses of electronic networking. So in addition to meeting the needs of today's users, research dollars should be allocated with an eye to stimulating applications for the next generation of networks.

D. Public Process is Essential

Much of the recent negative publicity surrounding the NSFNET has come because important decisions about the network were made without opportunity for public comment or input from commercial Internet providers. The NSFNET is now managed with the help of a number of advisory boards, such as the federal Network Advisory Committee. As the NSFNET and NREN grow, they will be built with the participation of many more service providers than are currently involved in the NSFNET. Therefore, it is important that the NSF's advisory boards be expanded to reflect new market conditions. With broader representation on these boards, the NSF will be sure to receive the guidance it needs to make wise implementation decisions.

IV. Conclusion

I want to thank the Committee for inviting me to appear on these important matters at this critical moment in the development of the NREN. I am optimistic that with Congressional leadership government agencies, public institutions and the private sector can work together to realize the highest goals of the NREN for the benefit of all.

For Further Information Please Contact:

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Mr. **Boucher**. Thank you very much, Mr. Kapor, and the chair's apologies for mispronouncing your name.

Mr. Schrader, we will be glad to hear from you.

Mr. **Schrader**. Thank you, Mr. Boucher and committee members.

My name is Bill Schrader, and I'm president of Performance Systems International. Thank you for inviting me to assist your efforts in examining the policies for managing and operating the NSFNET. As you will read in my testimony, I believe the following issues should be understood by the committee pertaining to the actions of the NSF in operating the NSFNET backbone and preparing for the NREN.

A new public data internetwork industry flourishes built on technology developed by DARPA. It enjoys a growth rate which may even exceed the personal computer industry for the duration of this decade. In attempting to leverage its budget, the NSF used taxpayer funds ostensibly to stimulate network research and development. Actual technologies applied were of questionable quality and did not promote innovative work by industry leaders. This is an inappropriate use of Government money.

The Government has privatized the ownership of a Federal resource by modifying its contractor agreements without administrative due process. This privatization was done in secret, and information was withheld for nearly a year. The privatization agreement was disclosed inadvertently to me by the contractor when attempting to explain the complex infrastructure pool concept, which may be discussed later today and subsequently disclosed publicly by me. The privatization unnecessarily provided the contractor with an exclusive monopoly position to use Federal resources paid by taxpayer funds.

During the NSFNET backbone contract period from 1987 to 1992, the Government allowed its contractor and subcontractor to build conflicts of interest into the fiscal, contractual, and operational aspects of NSFNET backbone. The contractor and the subcontractor have interlocked directorates and many other co-mingled activities.

Further conflicts of interest serve the domestic and international interests of the contractor and include influence and knowledge of the Government Oversight Advisory Board, the NFCAC, and the technical standard setting body of the industry, the Internet Activities Board and the Internet Engineering Task Force.

The NSF failed to properly oversee this $15 million contract, paying in full for service for 15 months while to date the network is still less than 50 percent operational. NSF actively shielded the contractor from public or private scrutiny during the 15-month period of nonperformance and now prepares to unnecessarily extend the five-year contract by an additional 18 months at the same full payment stream.

The ANS, Merit, NSF, IBM, MCI partnership speaks consistently about improving our national competitive posture, but its actions speak more clearly. While it may not have been planned completely from the start, five years of consistent steps leave little doubt in my mind that ANS is now positioned as the NREN contractor with potential for monopoly control in this explosive market.

A mid-course correction cannot undo the errors of the past but can set the stage for the future. Among these critical steps are termination of the partnerships contract on schedule, cancellation of the proposed backbone rebid. NSF should act on its own proposal to fund connecting institutions directly. If the NSFNET experience is to be used to achieve the goals of NREN, then an open and competitive marketplace must be supported rather than hindered by Government activity. A level playing field can only be built by changing current NSF policies which favor one competitor.

Thank you.

[The prepared statement of Mr. Schrader follows:]

Testimony
invited by the
U.S. House of Representatives
Committee on Science, Space, and Technology
Subcommittee on Science

Hearing on the Management and Operation of the NSFNet by the National Science Foundation

12 March 1992

By

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Executive Summary: The Internet, the most innovative mass communications infrastructure of this century, was begun by DARPA and is now primarily managed by the NSF. This testimony briefly describes my knowledge of a series of actions, agreements, and events resulting in the inappropriate privatization of the NSFNet backbone. Given the private nature of the agreements, the delay in revealing the agreements, and the apparent conflicts of interest shared by the principals, I am providing this Subcommittee with my understanding of the dates, involved parties, public rationale, actual results, and my conclusions regarding this privatization of the NSF resource. These actions were unfortunate and unnecessary and should be repaired before the government invests even more heavily in attempting to achieve the goals of the NREN.

Mr. Boucher, Committee Members and staff:

My name is Bill Schrader, and like my carpenter father and his father before him, I am a builder. In 1989, a long time friend, Martin Schoffstall, and I saw an opportunity to build a company to sell computer networking services to colleges and businesses around the world. With our spouse's and children's full support, we borrowed against our houses, withdrew our savings, worked two jobs, raised money from our parents, family and close friends and founded Performance Systems International, Inc. (PSI). We now employ 40 people in offices in New York, Virginia and California, serve 1,500 organizations plus 3,000 individuals in forty states and ten countries. In terms of marketshare, we are about 15% of the world-wide network of networks called the Internet. We are profitable and pay taxes.

Prior to PSI, I helped start NYSERNet, one of the first Regional Networks, with Dr. Richard Mandelbaum, Marty Schoffstall and others. I also helped start two supercomputer centers, one at Cornell University with Kenneth Wilson and one at Syracuse University under DARPA. My career for the past 12 years has included many areas covered by the HPCC.

We operate our own public data internetwork, called PSINet, consisting of a nation-wide T1 network using leased telephone circuits and PSI owned equipment. PSINet is interconnected with all similar U.S. commercial networks through the Commercial Internet Exchange Association, (CIX) which we helped found to ensure an open and level playing field for this new industry. The CIX is headed by Mitchell Kapor as Chairman of the Board. We connect to the NSFNet backbone for research and academic activities, and to several international networks. Through these many connections, our customers communicate electronically with all of the 7,500 organizations on the global Internet and the 20,000,000 people who read electronic mail regularly. Our services range from unlimited electronic mail for an organization at $25/month (suitable for high schools and small businesses), to high performance full service supercomputer connections at over $50,000 per year.

We are technology builders, having led the industry in the design of network management software, now licensed to DEC, SONY and over two hundred other computer and telephone systems manufacturers, resellers, and consumers. We are actively helping many small and large computer software, hardware and service companies begin to offer their products over the network. We are pleased to be competing in this industry and believe it is one area where American companies enjoy a lead and are well positioned to keep it.

The information I am providing today covers three topics:

1 NSF Policy Decisions
2 The Economics of the NREN
3 Recommendations for Congressional action

1. NSF Policy Decisions

The NSF initiated and operated the NSFNet program during a rapid evolution of the technology and the demand in the marketplace. Below is a brief review of some decisions made by NSF.

Decision A NSF Signed Merit/IBM/MCI contract - 1987

- Rationale - Achieve a national backbone network rapidly by leveraging the NSF budget by inducing private contributions of: a) equipment, b) personnel, and c) bandwidth, and encourage the development of high speed networking technology.

- Actual Events/Impact - One year was required to bring the network up reliably, because IBM computer equipment was used as routers, and new software had to be written. All the existing Regional Networks and other networks were using commercial grade, off-the-shelf routers available at that time. No IBM routers were ever marketed based on the design used in this project, and thus did not contribute to the nation's commercial position. MCI and IBM provided staff, but all network engineering, operations, and management work was performed by Merit staff (paid by NSF). Discounted bandwidth was paid for by NSF budget.

- Conclusion - The IBM equipment contribution was valued at about $100,000 per site, but could have been supplied commercially for $25,000 per site. In contrast to openly bid DARPA R&D programs in advanced technology, this program produced no useful prototypes and was delivered by IBM which was not leading in the field nor using any innovative designs. Except for the R&D staff converting computers to routers, the staff contributions by MCI and IBM were in sales and marketing. NSF essentially funded an IBM R&D project which never produced a product, and was justified on the basis of cost sharing to leverage the NSF budget.

  The success of the NSFNet and of the industry is not to be confused with the success of any individual contractor or grantee. NSF leveraged their budget by a factor of two by obtaining cost sharing in equipment and staff overvalued and not particularly well suited for the task. It is clear to many that the same amount of NSF budget spent without such leveraging would have produced a better, more reliable network, sooner, and would not have unduly shifted NSF policy to favor a single entity.

Decision B NSF requires international connections at backbone switches - 1989

- Rationale - To produce organized international connectivity which is cheaper and better than marketplace decisions made by others.

- Actual Events/Impact - For all new connections using any NSF funds, all connections were terminated at Merit/ANS nodes, allowing ANS to own the connection to a foreign market. Free market decisions by non-NSF funded parties were delayed up to 6 months, while NSF insisted on seeking approval from foreign PTTs for these "non NSF connections". Connections from the UK, Germany, Singapore and Korea which involved no NSF funds were denied access to NSFNet for up to six months. According to NSF, this delay was caused by State Department regulations.

- Conclusion - NSF has effectively given ANS indirect control over many international connections, while free market connections continue to be delayed.

Decision C NSF approves ANS organization, (and privately authorizes ANS's exclusive use of NSFNet for commercial use) - 1990

- Rationale - ANS was formed by the Merit, IBM, MCI team to leverage MCI/IBM equipment, staff, and bandwidth and to position itself for competition in the future. Private ANS meetings with NSF and select Regional Networks, and public comments about a complex shared "infrastructure pool", introduced a packet charging concept (called settlements) which ANS would fund by charging commercial customers attaching through the Regionals. There was no public mention or debate of the exclusive commercial use by ANS, which was the key element of their earlier private agreements with the NSF. Yet, these private agreements between NSF and ANS drove these complex agreements with the Regionals.

- Actual Events/Impact - This situation publicly positioned ANS as a not-for-profit, public spirited company willing to share its "profits" with Regional Networks which were willing to sign additional (complex) agreements. NSF approved this subcontracting arrangement without prior public notice, debate, or open bidding. Further, NSF helped provide visibility with press releases quoting Senator Gore and Dr. Wolff.

  Once approved, ANS took over the NSFNet leadership from Merit in the marketplace by hosting all negotiations and discussions with Regionals, and issuing policy/contract related statements which represented NSF backing. ANS began competing for commercial and non-commercial customers by telling prospective customers that they could "connect directly to the backbone" without using the Regional Networks, and that they should connect to ANS since "at any time, ANS could disconnect PSI or any of the Regionals which had not signed the ANS agreements".

In 1991, ANS represented itself as the only network which could guarantee full commercial use of the NSFNet. This was true then and is true now. One example of this is Dialog, a large commercial supplier of electronic information to academic, government and commercial users. It appears that ANS first convinced Dialog that it should connect to NSFNet (ANSNet) for "commercial only" traffic. ANS then attempted to use Dialog to attract the Regional Networks to sign the complex ANS connection agreements, preventing those who did not sign from reaching Dialog. Few Regional Networks signed, and when Dialog discovered that it could access fewer than 5% of the Internet users it converted to a normal ANS customer, and agreed to comply with the NSFNet policy of supplying only research and education traffic.

- Conclusion - NSF has thus positioned the ANS/Merit/NSF/IBM/MCI partnership to approach commercial, government, and academic customers with significant advantages no one else can offer, without disclosing this to the public or allowing anyone else to bid.

ANS's handling of Dialog's attachment, and subsequent month long delay in disclosing Dialog's request to change, was seen by many as clear positioning for ANS's for profit subsidiary ANS CO&RE to gain marketshare.

Decision D Upgrade T1 to T3, and Privatize the NSFNet - 1990

- Rationale - Push networking technology to avoid congestion on the T1 backbone. Leverage NSF funds by allowing some private use.

- Actual Events/Impact - NSF negotiated the T3 upgrade arrangement with no apparent technical compliance specifications and no penalty clause for non-compliance. To date, less than half of the T3 nodes are operational beyond test mode, after 15 months of full payments, despite intermittent claims of full operational status by NSF and the contractor.

ANS used IBM-provided T3 equipment which was not the same as that used on the T1, had no significant R&D preparation, and failed when deployed. As during the earlier T1 IBM router design, the commercial R&D on T3 routers had been underway for two years by other router vendors using their own limited funds (eg. Proteon, Cisco) and could have been used. The use of IBM computers produced a poor quality network, and damaged these leading commercial suppliers investment in R&D.

In November of 1990, ANS's president claimed in a public talk at a Harvard workshop that "in essence, we have privatized the NSFNet". Although few understood, he meant that the NSF was now buying its

NSFNet service as a portion of ANS's private network, rather than paying him to operate the NSF's network. While the NSF had sole use of the NSFNet T1, the NSFNet T3 was provided through a "cloud" and could also be used by ANS for their own customers. After the agreements which the NSF had signed creating ANS, and providing it with exclusive commercial access were released in December of 1991, it was clear that ANS's president was correct, the T3 had been privatized. This occurred without public discussion or disclosure, and was effectively hidden for a year.

- Conclusion - NSF perceived a need to leverage its budget further, enlarged the scope of the contract from T1 to T3, upgraded the financial size from $4 million to $10 million per year, and privatized the original contract, using private agreements, without additional bidding, and without notice once it was completed.

Privatizing a federal facility without notice, and at no cost to the recipient/contractor is improper and should be illegal for any agency of the government.

Decision E NSF and other FNC agencies accept apparent conflicts of interest, and unclear boundaries, routinely

- FNC/ANS - The Federal Networking Council (FNC) consisting of NREN agencies created an Advisory Council (FNCAC) charged with helping agencies understand how to best spend NREN funds. On the FNCAC are the venture funding directors of ANS (John Armstrong from IBM, and Richard Liebhaber from MCI), and another member of the ANS board, Mr. Joe Billy Wyatt from Vanderbilt University. No private providers are represented.

- ANS Formation - The Chairman of the Board of Merit, Inc., Dr. Douglas Van Houweling, negotiated the multimillion dollar government subcontract with his newly formed subcontractor, ANS, for which he serves as co-founder and Chairman of the Board. When ANS formed its for-profit subsidiary ANS CO&RE, he also became its Chairman of the Board. He remains on the Board of Merit, and as Vice Provost for the University of Michigan, oversees the President of Merit, Inc. He sits here today representing Merit, Inc. to Congress.

- NSFNet Operations - For both operational and oversight questions, Merit retains the prime contract for the NSFNet. It subcontracts 100% of it's responsibility to ANS, which operates the T1 network as an NSF facility and the T3 network as ANSNet. ANS then sub-subcontracts some, or all of, the technical and operational aspects of the NSFNet and ANSNet back to Merit. This apparently includes ANS's non-commercial customers as well as its commercial ANS CO&RE customers. ANS staff use computers at Merit, Inc. and the University of Michigan for their work. ANS can subcontract to any new subcontractor without NSF's approval. When something fails to work on this network, finding the person (or organization) who has an "arms length relationship", that is, who will withhold payment for non-compliance, is not possible.

- ANS/ANS CO&RE - An ANS salesperson who is selling a commercial or non-commercial connection to ANSNet does not know whether he/she is charging travel and labor hours to ANS or ANS CO&RE until after the sale is made. ANS CO&RE pays tax on profit, which is revenue in excess of cost. However, does ANS CO&RE's cost include the circuits paid for by MCI's donation to ANS (the not-for-profit), space rented by ANS for its offices, ANS CO&RE's prorata share of the depreciation of equipment donated by IBM to ANS, the travel costs by its Chairperson/Board member to testify before Congress when wearing at least three hats? Do funds received from government contracts pay for attorneys, accountants, and public relations firms to keep these involvements straight and attempt to present the correct image to the government and the marketplace?

- Standards Process - ANS hired a number of well positioned people in the industry, including the head of the Internet's public open technical group, the Internet Engineering Task Force, as one of nine vice presidents. Dr. Phillip Gross continues to hold his position in IETF. This provides ANS (and ANS CO&RE) with advanced knowledge of industry technical developments as well as some influence in guiding the timing and structure of emerging standards.

- Conclusion - Clear or apparent conflicts of interest situations occur in many aspects of ANS, Merit, NSF, IBM, and MCI. The entire group, which is now publicly self-characterized as a "partnership" has total control over the $50 million NSFNet backbone contract, now privatized, and well positioned to win any NREN contracts in the future.

In my opinion, there is little question that the actions of the ANS, Merit, NSF, IBM, MCI "partnership" have:

1) interfered with international and interstate commerce;
2) used the structure of the arrangements to influence NSF to make extraordinary decisions, privately;
3) planned their actions together, in advance; and
4) provided unfair advantage to ANS for the duration of the contract and beyond.

These arrangements do not provide a distinct separation between the role of the NSF oversight and the operation of the network by private parties.

The lines between the government and the contractor (grantee) have confused the regulators with the regulated.

Decision F NSF extends the Merit contract for 18 months, announces a rebid - 1991

- Rationale - More time is needed to plan the follow-on. NSF must provide the backbone because the Regional Networks do not want to take responsibility for buying their own connections, even with NSF funds. There is concern that two backbones cannot operate together smoothly with today's technology.

- Actual Events/Impact - Extending the current contract provides up to $15 million more to ANS without competitive bidding, assuring ANS and Merit a steady revenue stream for 28 more months. ANS maintains its exclusive rights to sell direct backbone connections and guaranteed commercial use of NSFNet to all commercial and non commercial customers.

  When, and if, a follow-on contract is signed and implemented, the NSF rebid plan calls for the same bandwidth, and a reduction of payments for each successful bidder to $3 million (down from $10 million).

- Conclusion - It seems that the NSF will save at least $4 million per year ($10 million current cost, $6 million for two suppliers after the rebid) if the rebid is completed before the Merit/ANS contract expires in November 1992. ANS continues to establish its own policies, representing them as NSF policy, such as settlements and infrastructure pools described earlier. There is a danger that this appears to be NSF policy which it is not.

  In my opinion, NSF hired a contractor and then allowed that contractor to unfairly influence its policy, funding, and technical decisions through the period of the contract and beyond. Many decisions were made, but some of the more serious policy and contracting decisions failed to recognize the larger market, were made privately without open discussion, did not allow full participation, and did not follow proper contracting procedures.

2 The Economics of the NREN

Sound economic principles may have been considered in the design of the NREN legislation. However, the market has evolved more rapidly than planned. Basic market forces have shifted the geographic, economic, technological and political realities of the NREN to their natural equilibrium of ubiquitous networking. Therefore, rather than investing NREN's hundreds of millions of dollars in the technology, it is better to invest in connecting people to the network, making it easier to use, and teaching them how to participate.

NREN is still built on the principle of "putting money into the backbone". It has been proven by the ANS contract that doing so produces little innovation and results in no self-sufficiency, since organizations will not pay for a free good. The correct method for government involvement in a burgeoning industry like this is to subsidize individual target organizations: colleges and public libraries at first to ensure public access, then high schools and elementary schools to ensure access for children.

A program using "Yellow Stamps" was first proposed in 1989 by the National Research Council's report "Toward a National Research Network", and again in 1991 by Dr. Wolff. In this program, NSF would directly fund these organizations' networking projects, and could be traded in with any network supplier which had met the criteria established by NSF. This program would require serious work to handle thousands of organizations, but would create the most stable results and still allow the national network to reach gigabit speeds in the same time frame. The difference is whether the NSF feeds the market at the bottom, or attempts to lead the market with advanced technology. Since the market has been reliably ahead of the NSF's technical program for the entire five year term of the current contract, there is sufficient reason to believe NSF cannot lead the market and, therefore, should feed it from demand.

If this program is created, I believe in five years we will see:

- local control and interest, where users come to value the network
- local leveraging of funds, 100 to 1 as seen in the university sector
- local control to buy from provider(s) of choice, on local schedule
- opportunity for all competitors to offer services, build economies of scale on their own initiative.
- a natural, permanent aggregation of traffic from hundreds of thousands of small and large NREN target organizations
- a natural convergence of commercial and NREN traffic on the highest speed "gigabit highways", taking advantage of fiber economies of scale
- no single monopoly, but instead a working, integrated commercially built operation provided with the service distinctions required by each market segment
- a smooth way for government funds to be ramped down after the five year program, for those organizations which participated in the early days
- direct political recognition of NREN's value in each local area, by parents, teachers, local political leaders and taxpayers.

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3 Recommendations for Congressional action

Overall Direct the NSF to A) remove the unfair advantages ANS has acquired, B) to consider industry and economic trends in future policy decisions, and C) to cease signing large contracts without administrative due process.

Specific Actions:

- Terminate the ANS contract on schedule. Congress should direct NSF to force ANS to either:
  A) remain under contract for NSFNet funds for the duration of the contract and extension, providing a service only to NSF, or
  B) sell commercial and academic access connections on the open market, but terminate the NSFNet contract on schedule in 1992.

  ANS cannot be allowed to continue both the contract and the private use, since it will then be able to continue to use its government subsidized backbone network to offer its service to commercial and academic customers at prices which do not reflect actual cost.

- Open Commercial Access. Congress should direct NSF to either remove ANS's right to sell commercial access to NSFNet funded gateways or to allow other commercial carriers equal access at no cost.

- Make NSF the NREN lead agency. NSF is best equipped to handle thousands of small proposals involving colleges, K-12, libraries, and similar NREN activities.

- Require accountability for NREN funds by NSF. NREN funds have few controls now, being split over four agencies. There is no direction or control in the implementation strategies among the four agencies, each of whom can spend it any way they wish. At the very least, agencies should be directed to report how the money was spent.

- Request that Dr. Wolff develop his "Yellow Stamp" program to distribute funds directly to institutions. America's libraries, colleges, secondary, and elementary educational institutions and non-profit research centers would then be able to use the funds solely to purchase internetworking services.

- Maintain "research funding" but do not confuse operational network access with network research. It is clear that the commercial marketplace is properly motivated to invest its own resources without government R&D subsidy. The government should limit its R&D scope to innovative industrial/academic research in high speed communications technologies and applications at the frontier.

Mr. **Boucher**. Thank you very much, Mr. Schrader, and the chair compliments all of the witnesses on their brevity and conciseness this morning. We have kept exactly within our time limitations.

We have a lot of questions. Let me begin with what I suppose is the most obvious of these. There are other networks available apart from the NSFNET which those who wish to interconnect with other facilities can use, and, that being the case, I would be interested in the response of these witnesses to the suggestion that perhaps a Government subsidy for the NSFNET itself is no longer needed, that obviously we need a Government program to develop a higher capacity and to move toward the NREN, but that for mere operation of the NSFNET itself, perhaps a Government subsidy is no longer required.

Some suggestions have been made that if the subsidy is eliminated some of the less wealthy users might be disadvantaged, and I would appreciate your response to that suggestion, but generally let me just place that question before you, and, Mr. Kapor, let's begin with you.

Mr. **Kapor**. We have discussed this very issue in the commercial internet exchange, and a number of our members have indicated that if there were an open opportunity to compete for the business which is not present by virtue of the continued existence of the NSFNET, they would be in a position to add enough capacity to fully reconnect the network at whatever speed people wanted, T-1 or T-3, and I've heard that not just from one member but from multiple members. They are held back from making those investments because they really do not have a marketplace-based opportunity to compete for that business.

So the answer to your question is, as regards the production network, the day-to-day network that is used by the overwhelming majority of the users, we believe the era is upon us in which a Federal subsidy to subsidize the network itself is no longer needed.

What may be needed in order to ensure equitable access for users is funding directly to particular classes of users who might not otherwise be able to afford the connection.

Mr. **Boucher**. So your suggestion is that if there is to be a subsidy rather than continuing the current practice of providing that subsidy to the service providers themselves, that the subsidy perhaps should be directed toward classes of users that might otherwise be underserved and not have access to the networks.

Mr. **Kapor**. That is correct—colleges, universities, junior colleges, k-12; there is a very broad constituency that should be ultimately connected to the net, and I understand it is the function of the NREN to do that.

Mr. **Boucher**. Let me get the response of our first three witnesses to that recommendation.

Mr. Roberts, would you care to respond?

Mr. **Roberts**. I think that the issue here has to be framed in terms of the transition we are attempting to make from a precompetitive network environment to a competitive services environment, and there's a tendency to think about this in static terms—for instance, that since it is now standard procedure to buy, and you can buy commercial T-1, TCP/IP services, that we have reached success. In fact, we haven't reached success at all.

The challenge is to move this technology forward into the broadband era. Other countries are preparing very rapidly to do so; large investments are being made. It is absolutely essential the United States make such an investment to aid this transition and the Government take leadership in it, and it is, in fact, embodied in the Act that the goal for the NREN is a functioning end-to-end gigabit network.

There have been a lot of questions asked about how to do that. It is the committee's job and our job in the community to help exactly tease that out, and the bill requires quite a number of studies over the next 12 months, in which OSTP is to take the leadership, to sketch out that terrain.

So I think that the answer to your question is that we don't regard—in the university community—we don't regard a production NSFNET as an appropriate role for NSF or for the NREN. In fact, given that CIX exists, that it is making money, it is selling services, we view that as evidence of a layer of use of the internet in the United States that demonstrates the successful transfer of the technology.

So there are going to be layers, there are going to be—we are in a heterogenous environment; there are all kinds of non-TCP/IP data networks, and the hope—the aspiration is that we will begin to converge out of this what I have called in some presentations a higgledy-piggledy mess that we have today.

But it is absolutely essential that we not forget that somebody has to push the leading edge forward, and the universities believe that the NREN is the vehicle by which we should do that and that the next cooperative agreement should mandate that pushing forward.

Mr. BOUCHER. I think we all agree that Government expenditure is necessary to develop the technology for the NREN; there is no debate about that. My question is, can we distinguish that effort to advance technology for the NREN from the current subsidy that is being provided for the NSFNET itself? And the suggestion that Mr. Kapor made is that rather than providing that subsidy to the service providers where it is being directed currently, that we send it to the user community to ensure that those who might otherwise be underserved or not have adequate access to the network would have it. What is your response to that?

Mr. ROBERTS. We simply don't have a situation in the United States in education and research where there is any feasible way to do that. It could only be addressed on the basis of some massive entitlement program. Once that you decide that a student or a group of students is entitled to access, where do you stop? There's 50 million students in primary and secondary schools; there's 14 million students in higher education; there's four million graduate engineers and scientists in the United States. It is not in the national interest to start out on another entitlement program.

Mr. BOUCHER. So, to summarize that response, you would say that as a mechanical matter it would not be possible to administer a program of providing the subsidies to the users, that we must continue providing the subsidy to the service provider as a way to assure that those users will have access to the network in the event that they don't have the financial resources to purchase that access otherwise.

Mr. **Roberts**. I don't think that "subsidy" is the appropriate term at all here. What we are talking about is an investment, and I think we shouldn't overlook the fact that NSF, even at the level of the backbone, has provided the smallest portion of the funds. The NSFNET partners have provided far more investment funds in the course of the current agreement, and, furthermore, even that investment is on the order of 10 percent of the total funds expended on an end-to-end basis by the universities and by the regionals which Mr. Hood represents.

Mr. **Boucher**. All right. Let me get Dr. Van Houweling's comments.

Dr. **Van Houweling**. I think that the notion that we would have a multitude of suppliers competing in a marketplace for providing service to a multitude of users is probably already true. What a lot of people fail to realize about this is, we have tens of regional network supply organizations. You heard about a number of organizations, some of them represented at the table today, who provide service in this environment. There is no situation today that inappropriately restricts the access of individuals to this network infrastructure and keeps people from making investment.

The concern is, what about the backbone service? Well, the important things to realize about the backbone service, in my view, are, first of all, that there are very significant scale economies in telecommunications provision, and that one of the major reasons for moving in the direction of T-3 networks and higher band widths later on is that aggregating traffic into a consolidated backbone actually reduces the cost of providing the backbone service.

The second major issue, I think, is that we need to have a national agreement on the type of service we provide in the backbone, because that small investment sends a clear signal to all of the other investors about how they maintain a coherent network for the Nation.

What we have succeeded in doing here, to a large extent, has been not the result of Federal investment dollars actually doing the work but Federal investment dollars leading the way and showing individuals how they can invest to be part of a network, and I think that is what we have to maintain.

Mr. **Boucher**. Well, let me be very concise about the question. You know, I accept your very eloquent response, but let me make it a little sharper. You know, we are leading the way, and, in fact, we now have the High-Performance Computing Act on the books with a very large share of Federal dollars devoted toward this further network development. That is the next generation. What I am focusing on for the moment is the current generation, the NSFNET.

Now realizing that we have put aside this large amount of Federal dollars to move us toward the NREN and gigabit speeds, do we still need to continue to provide money, public dollars, for the management of the NSFNET, or given the fact that there is competition in that provision of backbone service today, should we rely on that multiplicity of competition to do the job for us?

Dr. **Van Houweling**. Very briefly, I'll say that I believe the Federal investment is absolutely vital for the backbone at the national level because—

Mr. **Boucher**. But why is that? What do we get for it?

Dr. **Van Houweling**. And what we get for it is a coherent network nationwide, first of all; second, we get a lower overall cost of providing the service.

Mr. **Boucher**. All right. Well, we have a concise response now, Mr. Kapor. Would you like to respond to the response?

Mr. **Kapor**. Sure. As to the feasib—or infeasibility of implementing funding the educational institutions themselves, I don't believe it has ever been demonstrated, certainly not publicly, that it is infeasible. I think before we dismiss that as an alternative, it really should be explored with great seriousness, because there is an opportunity cost to continuing to have a centralized subsidized backbone which are the marketplace distortions referred to earlier.

Second, we contend that at this point for T-1 and T-3 speeds, which is what we are talking about, the private sector can be more efficient, cheaper, and more reliable, because it will be competitive in providing the exact same services that are today provided on the NSFNET, and we have member companies that are not making those investments because that opportunity is being artificially constrained, and we would be happy to find an appropriate forum in which to sit down and discuss that to show its technical and economic feasibility

Mr. **Boucher**. Well, I think we have noted that as a subject for further consideration, and this small debate this morning does highlight the need for that.

Let me get you, Mr. Kapor, to talk a little bit about the mechanics of the tilted playing field. You have indicated that the commercial service providers other than ANS and its profit-making subsidiary, ANS CORE, have a disadvantage. What is the nature of that disadvantage? Does it come about because of the economy of scale that Dr. Van Houweling is referring to, or exactly what creates the tilt in the playing field?

Mr. **Kapor**. First, it is both substantive and perceptual, but perception is also reality.

Mr. **Boucher**. Let's talk about the substantive part, if you would.

Mr. **Kapor**. Okay. There is, in virtue of the series of agreements between the NSF and Merit and ANS and other parties which are extraordinarily complex and opaque, in our opinion, a grant of an exclusive right to ANS that ANS's competitors do not enjoy to carry commercial traffic on the same physical facility which nobody else has the right to do, to carry the NSF-subsidized traffic and the ANS's commercial traffic, as well as to carry traffic across NSF-sponsored gateways or connections to the mid-level or regional networks, and nobody else can do that.

Since those mid-level networks are already all connected to each other through NSFNET and by ANS, ANS enjoys some inherent advantages in, for instance, attracting new commercial customers to join them, because they can offer greater commercial connectivity. The pitch which is made has been made is that, if you become a commercial customer of an ANS you have greater reachability, you have a larger market, in virtue of the particular relationship that ANS has to be able to carry commercial traffic out to all of the mid-levels, and none of the competitors can make that claim, and that right—now I want to be very clear about something. I understand that that right was granted in return for an investment by ANS and by IBM and MCI to actually build this network, and to leverage the Federal money, and to do a number of very good things; I wouldn't dispute that at all; but I really don't believe that there was due consideration given to the effect on competition of letting one carrier have a right to conduct commercial for-profit business over a facility which was funded in part with Federal dollars and not permitting anybody else to do that, and from the point of view of what is going to encourage free and fair competition, that is just not something which makes any sense, and I just believe that was failed to take into account.

I don't believe in raking over the mistakes of the past, but in setting policy directions for the future, since T-1 and T-3 networking can all be done off the shelf today more easily, in fact, than some of the travails with the recent NSFNET would suggest, I believe there is no economically justifiable reason not to move swiftly to that arrangement.

Mr. BOUCHER. So you are saying it is greater connectivity that ANS offers by virtue of the fact that it manages the NSFNET backbone that creates the disparity and the unlevel playing field. Isn't it true that any other commercial provider of network services can also connect to the NSFNET backbone?

Mr. KAPOR. They can connect, but they do not have the right to move commercial traffic, as opposed to research and education traffic, over that network.

Mr. BOUCHER. Well, but let me beg to differ with you. They do for a fee. There is a charge by the NSFNET for the movement of nonconforming traffic, and the conforming traffic is defined as that that is nonproprietary and for research and education purposes. If the traffic does not conform, meaning that it is proprietary or that it is commercial in nature, then it can still move on the NSFNET backbone, as I understand it, but there is a charge for that carriage, and that rule applies to ANS just as it applies to any other commercial provider.

Mr. KAPOR. Let me try to refine that a bit. The first thing is that it is an arrangement that is imposed not by the NSF but by ANS, and it is clearly—I mean it is true that ANS itself would have to obey the rules that it sets, but you don't have fair competition if one of the competitors gets to set the rules by which all of the other competitors pay, and, again, I'll point out that all of this working out of these particular arrangements about commercial traffic was done not through a public process, per se, but through an extension of the original cooperative agreement. But this manifest change in the nature of the NSFNET to permit the coexistence of commercial traffic was launched as a total fait accompli, with zero opportunity for any of the other players to register their comments on it.

So no, I would not say—while what you said is not inaccurate, I believe with the refinements I have added it shows it is just not fair.

Mr. **Boucher**. Well, I think you have raised another issue that we will turn to before long, and that is the question of consultation with the user and the service provider community, and perhaps that has not been adequate. I want you to elaborate on that shortly. But I want to stay for a minute with the question of discrimination against other commercial providers, because I'm not sure you have really correctly identified a subject of discrimination. Let me try one out on you.

I have heard it suggested that there is an economy of scale that inures to the benefit of ANS and its commercial subsidiary, ANS CORE, as a consequence of the fact that ANS is administering the NSF network, and that is a network supported in part with public dollars. That means that for each unit of traffic that is carried on that backbone the cost will be somewhat lower than if the public subsidy were not provided to that network.

Now tell me, is there any validity to that? That obviously would have an adverse effect on commercial providers on other networks, not on the NSFNET itself but on the other backbone services that are available. Is that a legitimate complaint? I don't mean to put words in your mouth here, but is that a legitimate complaint that competitors should make?

Mr. **Kapor**. I think the substance is absolutely legitimate. I would phrase it slightly differently but to the same point, which is, if the Government is going to come and prepay you $5 million or $10 million to build a network and give you an exclusive right to do something with it, and your competition doesn't have that business, yes, it gives you a big head start.

You might go ahead and make that investment when you would otherwise not have made that investment because you have got a guaranteed base of business and you have got a reason to build that network, and that is not—if that had been done without the grant of the right to carry its own commercial traffic, it would be a different matter, because that is the element which creates the distortions, so—and that was the situation previously; we backed up to that situation. While it is not what we would recommend fully, we would agree that it would correct the current source of major friction.

Mr. **Boucher**. All right. Now we have identified a possible source of anticompetitive action, let me ask you this. Do we solve that through the recompetition which NSF is proposing for later this year, or do we have to go to what I think you have proposed as another solution, and that is simply to say that a manager of the network may not have the opportunity to put his own commercial traffic on that network?

Mr. **Kapor**. I have to say that I think the proper discussions among all concerned parties have not taken place, certainly not out in the open, and those would be determinative of those answers. I think one has to be flexible about, for instance, how rapidly you could move to a zero backbone solution, and we would like to have, rather than a situation in which we are looking at an 18-month extension, the emphasis placed on saying, well, how are we going to move into the next phase, and what is the speediest path to that?

Mr. **Boucher**. Well, let me get responses from others here. We have heard a possible description of a means by which some of the providers of commercial services are perhaps not treated fairly. First of all, do you agree that there is a tilt in the playing field? and, if you do, is that properly accounted for in the recompetition which the NSF is proposing for later this year, or would it be appropriate to move on to the next step and simply have a prohibition on any manager of the NSF network also offering a commercial service?

Dr. Hood.

Dr. Hood. I think it is important to emphasize the point that we are still engaged in the process of building a research and education network infrastructure for the country and that we are still engaged in a grand experiment, that we are dealing with precompetitive technologies, and that the real value of the internet and NSFNET connectivity is delivering information resources to the desktop of the scholar and researcher.

That process, the building of that local infrastructure, the building of the State and regional infrastructure, has just begun, and the Federal Government, the subsidies that have been directed at the backbone and the mid-level providers are leveraging very effectively investments at the State and local level.

As we move to expand access to new constituencies previously underserved, such as K-12 education, such as libraries and health care, we are going to see a great need to continue to invest and leverage the development of infrastructure in those previously underserved constituencies.

The mid-level networks, by and large, are not-for-profit associations of the user communities. Most are managed by board of directors on which sit leaders within university communities, within the research and education communities, and the Federal labs, or leading players within industry who have research and educational ties to the university and higher education community. So there is a lot of avenue already for input into the operation of mid-levels and the backbone.

In terms of the current situation which is a balkanization of connectivity within the internet, we currently have, in fact, disparate islands of networking which are not fully interconnected. The mid-level networks would very much like to see that balkanization eliminated so that researchers and scholars within the higher education communities would have full access not only to the academic and research resources but also to the commercial services that are being provided on the network.

We are just now engaged in the process of learning and building the correct partnerships between academia, Government, and industry to advance these critical technologies.

Mr. Boucher. Do you think any discrimination exists against service providers today?

Dr. Hood. From a mid-level network perspective, we have the equal opportunity to buy commercial services from more than one network service provider.

Mr. Boucher. Do you discount the argument that, because ANS operates the NSF network which has Government support, that it is in a competitive position superior to other service providers because the unit cost for every item that it transports on that network, whether that it be its own commercial traffic or the public traffic, is lower? that lower cost inuring to its commercial traffic means that it can charge a lower rate for each item of traffic than its competitors and still make the same profit? Is there any validity to that argument at all?

Dr. HOOD. I certainly agree with the argument or the position that there is an economy of scale in national network and regional network provision, and given that argument, certainly the carrier or provider with the largest number of attached institutions is going to have a smaller marginal cost of attaching additional institutions.

Mr. BOUCHER. So doesn't that create a competitive disadvantage for ANS's competitors?

Dr. HOOD. It may. I guess I would like to once again emphasize that I think we are in a precompetitive environment, that we have not yet reached the stage that internetworking is a commodity that can be sold off the shelf and readily used in all areas of our society, and so—

Mr. BOUCHER. At what point do we reach the time when we ought to be concerned about that potential anticompetitive feature?

Dr. HOOD. I think certainly some of the issues that were raised this morning are being addressed in the recompetition of the NSFNET backbone award. The plan that has been put forward by the Networking Division within the National Science Foundation really focuses on two objectives. One is to maintain the stability of the network so that our education and research communities continue to be advantaged, and the other is to provide an environment in which open competition will be allowed.

Mr. BOUCHER. Do I interpret that answer correctly to mean that, in your view, the recompetition for management of the NSFNET will resolve any problems that may exist with regard to some unfairness among competitors?

Dr. HOOD. It certainly will establish an open, competitive environment. Whether it will resolve all of the issues I can't say.

Mr. BOUCHER. Mr. Kapor, do you think the recompetition alone will solve the problem?

Mr. KAPOR. If the recompetition is set forward with the explicit goal that the terms of the recompetition must be to have a level playing field, yes, then that is possible, but without that goal it is unlikely.

Mr. BOUCHER. All right. I have been dominating the time here, and I'm going to yield in just a minute. Let me just ask if any of the other panel members want to comment on this range of questions before we conclude that part of the discussion.

I don't see any takers.

The chair recognizes the gentleman from California.

Mr. PACKARD. Thank you, Mr. Chairman. I think you have been very specific in your questions and direct.

Let me address the question of the present policy of NSFNET, the backbone system. It has been a policy, I believe, that the services be at no charge to the research and educational community. Is that policy widely known and widely understood and, thus, widely used, Mr. Van Houweling?

Dr. VAN HOUWELING. I certainly believe so. There are—the signal is that there are hundreds of universities and colleges all over the Nation who are, through the regional networks, availing themselves of that service.

Mr. **Packard**. Should there be restrictions on the uses of the network?

Dr. **Van Houweling**. I believe it is critical that we make a distinction between the research and education network on the one hand and some national information infrastructure on the other hand, and if we aren't careful about the usage guidelines, I think we will lose that distinction and there will be a lot of confusion about what, after all, the purpose of this Federal investment is.

Mr. **Packard**. To what extent are the NSF network services available to the commercial sector? Approximately what percentage of the services are used by your commercial versus your research and educational communities?

Dr. **Van Houweling**. Well, speaking from Merit's point of view, I can say that through the various regional networks around the country and the options they have for connection, in fact I have not discovered any commercial organization that found it difficult to find a connection. Indeed, the knowledge I have from my experience in one of the regional networks—that is, Merit—is that there are multiple opportunities for commercial organizations to get connected to the broader internet.

Also speaking from Merit's point of view, it is my understanding that the actual amount of commercial traffic now being carried on the backbone is in the neighborhood of just 1 or 2 percent; it is very small.

Mr. **Packard**. Why is that?

Dr. **Van Houweling**. I assume that it is primarily because there are a broad number of other opportunities that are economically feasible for the carriage of that traffic, and also I think that we have not tried primarily to focus on serving that community, we have primarily focused on research and education.

Mr. **Packard**. If the Government no longer remained a participant or a supporter of the program, would it disappear, or would there be the availability of the networking services to the educational and research community?

Dr. **Van Houweling**. You should probably ask my colleagues that question. They are probably in a better position to answer it. My own position as a board member of Merit is that, without the backbone service, in fact, the very successful structure that now exists would wither away.

Mr. **Packard**. Would disappear.

Would the commercial sector, Mr. Schrader and Mr. Kapor—would the commercial sector find—or what would be the way that the commercial sector would pick up the educational and research needs in terms of networking?

Mr. **Schrader**. Mr. Packard, we provide service to 1,500 organizations right now. Some include large universities, but dominated by commercial outfits. All the commercials have access for research and education type traffic to the NSFNET. We have a nationwide backbone. There are other commercial providers with nationwide backbones. We could upgrade that backbone to T-3 within 90 to 180 days if we knew that there would be a market.

Mr. **Packard**. In your judgment, why would the universities come to you for services in preference to the NSFNET?

Mr. **Schrader**. No university would come to us, because we have to charge them money; the NSFNET backbone is free. So if the NSFNET backbone charged them money, then we would have an ability to compete.

I disagree completely, although I understand Dr. Van Houweling's argument; his backbone could not survive, but the industry is here to stay, and there's no indication that it will slow down in the slightest.

Mr. **Packard**. Mr. Kapor, do you have a response?

Mr. **Kapor**. Yes, I certainly agree with that, and I just want to put this in the framework that technologies mature, and when they mature, when they are no longer precompetitive, the most efficient solution is to let the private sector compete fiercely with each other to offer the best products at the lowest cost. There are at least two private carriers that have national backbones today, both of whom would be eager for the opportunity to provide services to colleges and as we have suggested, it is—would continue to be an appropriate role for the NSF, the Government, to support those colleges and yes and research institutions, we advocate, through a direct grant system, and I just find it very difficult to believe that the Government is incapable of administering a program to provide grants to universities such that they could go and purchase network services on the open market the way they purchase computers and work stations and other scientific equipment and have for a long time.

Mr. **Packard**. Mr. Roberts, on what basis would you suggest that recompetition proceed?

Mr. **Roberts**. Well, as I indicated previously, I really believe that the goals of the legislation can only be met by a cooperative agreement which explicitly calls for a substantial improvement in the backbone technology over the course of the agreement. T-3 is obviously not a satisfactory objective, and consequently what is important—and I wanted to speak to the issue of the so-called extension of the current agreement. Our task force directed a letter to Dr. Massey last fall stating that we felt it was urgent for the Foundation to make up its mind about the competition and that we believed that an award could be made by September of 1992.

I think that I'm persuaded, subsequent to having sent that letter, that the Foundation, in fact, intends to explicitly call for improved technology, and it wants to give the industry, which is going to put several tens of perhaps hundreds of millions of dollars on the table in this issue of pushing the technology over the next four or five years to have an adequate time to contemplate how to do that.

As Dr. Hood has already said, we are still engaged in a precompetitive, experimental process of trying to establish the United States as the leading edge on a continuing basis in this technology.

Mr. **Packard**. Do you believe we are still in the precompetitive stage?

Mr. **Roberts**. Certainly with respect to broadband SONET services and that sort of thing we are, and I think with respect to the discussion about competition and the volume of services, you have to put this in the context of what the communications industry in general is doing. There are many Fortune 1,000 companies that are making heavy investments recently in TCP/IP technology, and my prepared technology used an estimate from Interop, Incorporated, that the value of that technology already exceeds $4 billion a year. It is not visible because it is invested by those corporations and private networks where they buy the boxes and they lease the circuits and it is all in their general ledger.

The communications industry has belatedly discovered that if they don't get their act together there isn't going to be any of this business for them because it is all going to be private because the deregulation of in—a lot of services permits this to happen.

So we already are seeing a whole lot of activity by the bells with services such as SMDS and now they are talking about ATM and FDDI-2 sorts of things to provide a public tariffed packet-based service that will meet these needs, and one of the crucial roles that the Government can play right now is to push this thing forward so that people go from being terribly afraid to making investments in this advanced technology to saying, "Well, look, the Government has helped catalyze this, and it is happening; the universities are demonstrating that it does work, so we can afford to put the big industry investment behind it."

Mr. Packard. Where is the international competition in this field predominantly?

Mr. Roberts. The Japanese have a substantial lead in broadband technologies, very discouraging. Of the half-dozen broadband switches installed in the United States in the last six months, they are all Japanese, and I'm not—that is not necessarily a matter for today, but it certainly is a subject of considerable discussion with Dr. Wong who is now responsible for critical technologies for Dr. Bromley.

Mr. Packard. In your judgment, if we recompete this issue on what some of the witnesses have declared as being a level playing field, what would that do in terms of our competition with the Japanese particularly and with the other international—

Mr. Roberts. It would provide a major—if the National Science Foundation specified that there must be a broadband component to the competition, I think it would play a major role in getting our industry galvanized to do something about this.

Mr. Packard. I would be interested in your response on that question, Mr. Schrader and Mr. Kapor.

Mr. Schrader. I'll go first.

I believe with all my heart all of the data that Mr. Roberts just presented. I just disagree completely with his conclusions. The industry is moving much faster than the NSFNET has in the past and will in the future. Sitting in the audience are all the major telcos and several commercial providers of TCP/IP service. These people can move things faster. I'm a small player, but we can move things just as fast as the technology will go. The Government investment will not push this technology any faster. It cannot do that.

Mr. Packard. Mr. Kapor, you suggested that recompetition would be acceptable if it were on a level playing field. What would have to be done to make that playing field level?

Mr. **Kapor**. I could suggest a couple of options. One option would be to do it in a way in which the network manager could not also play a commercial role. That would reduce the—or eliminate the possibility of marketplace distortion for the commercial sector.

Mr. **Packard**. So their service would be limited then to your research and—the free service.

Mr. **Kapor**. That is correct.

Mr. **Packard**. They would not compete with the private sector.

Mr. **Kapor**. Another possibility is to move to the other end of the spectrum and do it in a way that all commercial carriers would have equivalent access to whatever new backbone or backbones were put in place, and I won't sit here and tell you I know how to do that today, but I do think it is worthwhile to discuss.

What stands in the way of that today is really the acceptable use policy, and that is why we start out by saying that modifying that or dropping it to give all of the commercial providers equal access to these Federally supported and subsidized regional networks would be another way of leveling the playing field.

The distortion comes when you take one or, for that matter, two carriers, you partially subsidize them, and you give them commercial rights that nobody else has. So any situation which—any arrangement which gets us out of that situation is going to level the field.

Mr. **Packard**. So you are suggesting that either they be permitted—not permitted to compete in the commercial sector or that they—or that you be permitted to share the subsidization—

Mr. **Kapor**. And I have yet another option—

Mr. **Packard**. —of the commercial side of that spot.

Mr. **Kapor**. That is correct.

Let me mention, if I may, a third option, which is to separate out the idea of the production backbone—i.e., those services used by 99 percent of the users in research and education and industry for the day-to-day electronic mail and file transfer—and separate out that production network from an investment in precompetitive, ultrahigh-speed broadband networks.

My reading of the NREN is that it needs to serve both purposes, to expand the reach and to develop the high end, and I'm suggesting that we have differential policies as to how to do that. To expand the reach, let there be funding to the institutions to purchase services on the open market and let the private sector freely compete, because that will expand the reach inside research and education, K-12, and everywhere else.

At the same time, to develop the high end subsidy, network manager, experimental networks, broadband—this is all contemplated by NREN, Mr. Roberts has advocated—we support it, but we don't want to see it confused with the day-to-day production network that serves millions of users today, millions of whom are already in the commercial sphere; 60 percent of the institutions on the U.S. internet are commercial entities, only 40 percent or less are educational, and the rate of growth of commercial institutions on the internet far outstrips the rate of growth of educational institutions.

Mr. **Packard**. Dr. Van Houweling, I think it was you that mentioned that about only 2 percent of your business is commercial and industrial. How much money does that represent in terms of your budget, percentage-wise?

Dr. **Van Houweling**. We are speaking of now my understanding about ANS's business, and the answer is, a very small proportion.

Might I make a couple of observations at this point?

Mr. **Packard**. Of course.

Dr. **Van Houweling**. First of all, it seems to me that we have to be clear on whether the purpose of the High-Performance Computing and Communications Program is to move this Nation forward in the application and availability of the very highest capability networking that we can provide for a lot of purposes or whether it is to provide a level playing field for a competitive industry.

My understanding of the legislation is that we are supposed to try to move forward and push the frontier. In order to do that, we, in my view, need to work and trust the National Science Foundation, who has done such a fine job so far, in fashioning a program that moves that technology forward and provides broad access to that technology as it moves forward.

Now a bit of history here. Before this NSFNET program was started, the technology that you could get to do this work typically operated at very much lower speeds, and it was not a strong industry in the United States that was playing an international leadership role in this technology. That industry has now moved forward, but it is still the case that, given the latest tests that we have conducted, we cannot buy off the shelf T-3 routers that will actually operate a network of the complexity of the NSF backbone network today. We are still having to develop technology aggressively to meet today's demands.

If we are satisfied with the goal of creating a level playing field, then what we will get is a set of responses from industry which allow industry to make profit. Those will be safe responses that won't move us forward in technology.

Mr. **Packard**. Well, I'm not sure that this member of the committee agrees with your deduction in that the role of Government, particularly as it relates to our science committee, and the projects and the programs that we want to infuse taxpayers' dollars into are essentially to do just what we think this has done, and that is to move a fledgling, growing industry into a technology level to where the private sector can often do what Government no longer does effectively or efficiently. And the dilemma that we must face and the decisions that we ultimately must make, I think, is when is the cutoff date, not if there is going to be a cutoff date or not.

I think it is a question of when do you make that—when do you wean an industry to where American ingenuity and private sector abilities are able to go out now and compete in a world marketplace better than Government, because there comes a point, in my judgment, when the private sector can do just what you said we want to do with this better than the Government sector can do. And that is the dilemma and, frankly, the purpose for this hearing is to help us try to determine if we have reached that point or, if not, when, and so I think our goals are the same.

The tragedy often is that as we infuse and move Government into these—this emerging area and thus try to compete with international competition, because they too allow, and not only allow but really encourage Government involvement in their emerging technology fields. The question then becomes, when do we break it off? And we have got to—I think that is the decision we have got to make.

Mr. Roberts.

Mr. **Roberts**. I would just like to make a brief comment. I think that your remarks are well taken and that Mr. Kapor makes an excellent case for not relaxing acceptable use policy. If NSF were to relax the acceptable use policy, then obviously we would thwart the growth of commercial services of this character.

The objectives of the legislation, the program, are only carried out if we have this component of the total networking environment which is pushing the frontier forward, and the commercial sector, because it needs a market, because it needs a profit, is obviously always going to be behind the leading edge.

So we should not permit commercial traffic on our leading edge component, our developmental component of the whole network environment, and the prohibition against that traffic will force the universities, which are more and more into activities not related directly to what we are discussing here today or contained in legislation to use that commercial access.

Mr. **Packard**. Well, of course, you speak to a very interesting philosophy, and that is that because Government doesn't have to worry about profits, they therefore have a greater opportunity and more propensity toward staying on the leading edge. I tend to accept the philosophy more that in order to make a profit industry has to stay on the leading edge; they have no choice; if they don't, they simply do not—

Mr. **Roberts**. I don't think we are in disagreement at all, but I think that if you look at the evolution of various infrastructures and the history of the country and our economy, that Government has always played a key role in getting the thing established, whether it is canals or an air traffic control system; all of them have that.

Mr. **Packard**. And I think we have no argument with that. We wouldn't even be in this business if we didn't agree with that.

Again, it is a question of when is it time to wean, and I'm through, Mr. Chairman.

Mr. **Boucher**. Thank you very much, Mr. Packard, for those enlightening comments and excellent questions.

Dr. Van Houweling, I would hope that we are not in the position where we have to choose between advancing technology on the one hand and providing fairness on the other, and I got a sense from your statement that perhaps you thought we were placed with that choice. Did I misunderstand you?

Dr. **Van Houweling**. Yes, I think you did, and I understand why my comments might have been taken that way. I believe that, in fact, the plan the Foundation has for recompetition, I think, is an appropriate response to the questions that have been raised about fairness. My argument was simply that we need to have a continued, substantial Federal investment to make sure that we don't allow the backbone network technology to essentially fall behind the competition from other places on the globe.

Mr. **Boucher**. Let me ask this panel generally about the enforcement that exists, or the lack of it, with regard to the acceptable use policy of the NSF. What it basically says is that if the traffic crossing any of the 16 nodes is nonproprietary for research and education purposes, then that traffic comes on to the backbone for free, no charge is made. If, however, the traffic that crosses any of those 16 nodes has a commercial character, nonproprietary, or is proprietary, or is not for research or education purposes, then there is a charge. That is simply what the acceptable use policy says.

Now a number of recommendations have been made about it. One from Mr. Kapor is that it be dropped altogether, and I take it the effect of that would be that all traffic, commercial or noncommercial, would come on to the backbone for free. In support of that proposition, he says that there really isn't very good enforcement of the policy in its present form; there is no way really to distinguish in a reliable way commercial from noncommercial traffic, and perhaps some of the commercial traffic is coming on to the network for free today.

What is the response of this panel to that suggestion? Do we have good enforcement? Is there a way to know reliably what is conforming and what is nonconfirming? If not, can we adopt a policy that does put that reliability into the system? and, if we can't, should we consider dropping the policy altogether?

Dr. Hood.

Dr. **Hood**. The situation that we have today is one that is self-policing. The policies are widely disseminated—acceptable use policies are widely disseminated to the research, education, and industry communities, and, from my mid-level network perspective, a vast majority of our corporate partners are extremely sensitive to their obligation to abide by today's acceptable use policy, so sensitive to that that I think oft-times we miss the opportunities to promote a richer collaborative environment among industry, Government, and academia and that nationally we are missing some opportunities for collaborative research between industrial partners.

We are hoping to achieve a fertile mix of industry and university research efforts which will push the cutting edge not only in computing and communications technology but also in the major grand challenges areas, and we would like to propose not a complete relaxation of the acceptable use policies but one that would allow the use of the network by corporate partners for research and educational activities on an experimental basis where we could measure the effects and also somehow analyze the benefits of slowly relaxing those constraints while maintaining the stability of the backbone and keeping the level of service high.

Mr. **Boucher**. Are there other comments, Dr. Van Houweling or Mr. Roberts, on that question?

Mr. **Roberts**. I would just like to say that almost all universities now have a policy on the use of the computers that, in effect, are the end points of their campus networks, which are the end points of NSFNET, that govern appropriate use of those systems by their faculty and staff and students, and they are as restrictive or more restrictive than the current acceptable use policy, with possibly an exception here and there.

Mr. **Boucher**. That takes care of traffic that originates on a campus. What about traffic that originates at a corporation that uses ANS CORE as a means of connection on to the NSFNET? That is nonconforming traffic. How do we know that there is an enforcement of a fee for that traffic, as NSF policy requires?

Mr. **Roberts**. Well, each individual FARNET network has contractual agreements with the entities, whether universities or corporations, that sign up, and these provisions are incorporated in enforceable agreements. Beyond that, for someone who has a direct relationship with ANS, that is a for-fee-based arrangement.

Mr. **Boucher**. Dr. Van Houweling, are you satisfied that there is adequate enforcement of the policy at the network level?

Dr. **Van Houweling**. I'm satisfied that there is adequate enforcement. My experience both with the individuals that have worked with Merit and the individuals who have worked with ANS is that they are extremely sensitive to these issues and pay very close attention to the use guidelines.

I need to state clearly, however, that doesn't mean that there isn't some very small amount of traffic that sometimes moves because somebody doesn't understand it, but I think it is well below 1 percent of the traffic and has no major impact on either the commercial or the operational activities on the network.

Mr. **Boucher**. So your estimate is 1 percent or less of the commercial traffic perhaps does come on for free because of lack of understanding?

Dr. **Van Houweling**. I think that there are some individuals on some campuses or at some corporations that are connected that might be engaged in some activity and not fully understand, but I'm sure the organizations understand and do their best to publicize that broadly.

Mr. **Boucher**. How well understood generally is the acceptable use policy? Has it been widely disseminated, and do you think the user community is aware of it, Dr. Van Houweling?

Dr. **Van Houweling**. My experience is that we get a lot of questions asking about how it should be interpreted and so on, so there certainly is, in our opinion, very broad awareness of the policy.

Mr. **Boucher**. All right.

Mr. Kapor.

Mr. **Kapor**. I greatly appreciate your explicitly raising the AUP issue. I will make a very different characterization than what I have heard and would invite as proof of what I'm going to say a public demonstration where I could show this.

The fact of the matter is that, because of the success of NSFNET in the mid-levels, you have millions of college students as well as faculty and researchers on this, and while there is general awareness that there is an AUP, it in no way prevents the users of the network every day from conducting their life's business on it, and if that means discussing science fiction or posting product announcements or doing anything that they can get away with without feeling that they are going to call down heat on them, people do that, and that is the reality that goes on.

Self-policing is a polite way of saying that it is up to everybody to make their own interpretation, which means the most law-abiding

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people are the ones that have the least use of the network, and the ones that have complete disregard do whatever they want.

Let me point out that electronic mail is just about the most popular application on the internet, the contents of which are generally and, in fact, legally, with some minor exceptions, private. So no one is to know whether if I send a message to you, is it in service of research and education? (a), I would argue that that is quite indeterminate; people of good will will differ about that; and (b) I know from personal experience, if you look at the discussions that go on on mailing lists and in use-net news groups, and if you look at the contents of the libraries stored in what are called FTP, or file transfer protocol, sites, there is no principled way to say that what is going on is in conformance with any reasonable interpretation of an AUP.

There is one set of parties who suffers because of the AUP, which are businesses who wish to go on the net to offer information services to the research and education community, because as a business they have potential liability, and if I were to start a business 10 years after Lotus to serve the research and education community with some fee-for-service basis, I wouldn't do that, because I would be aware that somebody could come after me for not being in compliance.

So the sole result of the AUP, in my opinion, is to deny the R&E users of the network a chance to have the kinds of services which will make it more useful.

Mr. **Boucher**. Well, let me ask you a specific question about that, Mr. Kapor. If you are an information service provider to the research and education community, you are a business, you are not offering those services for free.

Mr. **Kapor**. Correct.

Mr. **Boucher**. You want to get a payment from the purchaser for the use of those services. Now under the current acceptable use policy, there is no bar on those services being offered over the NSFNET, you simply have to pay for having those services carried. So why does the acceptable use policy as it exists today serve as an inhibition for those service providers using the network? Is it because there is some lack of understanding of how the policy functions?

Mr. **Kapor**. May I respectfully disagree with your characterization. First of all, you have to go through ANS, you can't do it through any of the other competitive providers, so you are forced to deal with ANS—this gets back to the unfair playing field—and they set the terms and the prices and the fees. This is not free and fair competition.

Mr. **Boucher**. All right. Well, we are getting to a very interesting issue then. Let me get you to be very specific about this. Is ANS discriminating against information service providers and charging them an inappropriate amount for use of the NSF network?

Mr. **Kapor**. Our view is, as a policy matter, it is inappropriate to require all potential information service providers to go through a single carrier. I mean economically it is clearly going to be much less efficient than if carriers are competing with each other for business both of providers and consumers. But yes, I do think the terms are unreasonable.

Mr. BOUCHER. Why does it bother you that a single entity manages the network? I think that is almost going to be essential in any case. Why does that bother you? Is it because that entity also offers its own commercial service?

Mr. KAPOR. It is in part that, but I would make the point that while, in the predigital era, it may have been necessary to have a single manager of a network, the overwhelming trend in telecommunications has been towards competition and deregulation such that in telephony we are down to the issue of how are we going to create competition in local exchange having succeeded in getting competition in CPE and long-distance service?

I mean it is possible technically, given computer-based communications, to have multiple, interconnected parties and still have an operable network; I won't say it's trivial, but it is certainly possible; and there is a consensus in general that this is the desired direction.

In that context, going to a situation in which one is forced to go to the network manager in order to provide full commercial services is a retrograde motion and, I would argue, quite unnecessary and not in service of the research and education community.

Mr. BOUCHER. Let me ask you this. There are other networks available, are there not? The NSFNET is not the only alternative. Other networks are available. Why is it not an answer to your complaint that the offeror of information services to the research and education community, if he doesn't like dealing with ANS for some reason, could simply go to one of the other backbone services currently available?

Mr. KAPOR. Well, that, in fact, is viable up to a very significant degree, and one of the major functions of the commercial internet exchange is to provide such an interconnection service. At the same time, because regional networks in general get a free connection to NSFNET, they are disinclined to pay for an additional connection in some cases, and that is understandable. On the other hand, I would argue that they are not necessarily—those decisions are not necessarily serving their users well, and if you will just—I'll make a 15-second analogy.

The personal computer industry took off from a zero to $100 billion industry in large part because third party providers of applications and services like Lotus could enter in and did not have to seek permission, sign a contract, or have any business relationship with IBM or Apple or another provider, they simply hung out a shingle, as it were, and we got tens of thousands of companies providing applications which stimulated the development of that industry.

At heart, at the bottom of all the arguments that I'm trying to make is that we need to lower the barriers to entry for application and service providers by creating a level playing field and multiple competing carriers, because that is the only way we are going to get the innovation in the higher level applications and services that matter to users.

We are getting very good at pushing bits around at an extremely fast rate, but if you actually sit and talk to one of the millions of internet users and look at what they do, it is still arcane bafflegab, it is obscure and opaque in its user interface in the extreme, and I would claim that by doing the maximum to encourage private sector investment in developing applications and services is the fastest path to solving that problem, and it is why we stated so strongly the need to open up the network, provide a level playing field, and allow for multiple competition.

Mr. BOUCHER. Dr. Van Houweling, would you like to respond.

Dr. VAN HOUWELING. I'd like to respond briefly. First of all—and you should talk with the Foundation about this—I have seen mail from Dr. Wolff in which he says that he is willing to discuss with any network provider provisions for attachment to the sites that connect the regional networks to the backbone service, and he has invited participants to talk to him about that if they wish.

My first point is that there is not a monopoly here, there is an offer to open that up. The second point I would like to make is that it is precisely because the Foundation requested of Merit that the network be opened to the type of commercial access that Mr. Kapor has just discussed that we invented ANS and ANS CORE services so that within the existing acceptable use guideline constraints we could provide an open path for commercial traffic to the research and education network. It is precisely those objectives that we share for which we are now being criticized.

Mr. BOUCHER. Is it also true, Dr. Van Houweling, that if some other provider of network services desires to connect the information service provider to the NSF network that he will be able to do that? In other words, is it necessary that the offeror of those information services deal with ANS CORE, or could they deal with some other provider of the service?

Dr. VAN HOUWELING. It is absolutely the case that a provider of service can deal with any of the networks that are connected to ANS, to the ANS-run backbone service.

Mr. BOUCHER. So in order to use the NSFNET, it is not necessary that the offeror of an information service go through ANS CORE.

Dr. VAN HOUWELING. That is exactly correct. It can go directly to a regional.

Mr. BOUCHER. All right.

Mr. Kapor, do you want to comment? And then we are going to move on to another question, but I do want to hear this response.

Mr. KAPOR. Respectfully, I have to disagree with that characterization. There is a very large on-line data base service called Dialog, and they originally signed up to be a commercial customer of ANS. And after a very short period of time they backed off that and status to be a research and education customer. The reason is that not enough, hardly any, of the regional mid-level networks have signed the agreement that ANS has attempted to develop to permit the commercial interconnectivity.

Given those lack of agreements, Dialog was forced to employ the same fiction as everybody else and say, "Well, we're not commercial, we're just doing—we just serving research and education." But I take that as proof that the ANS model, while well intentioned to try to develop commercial services, is vastly inferior to a situation in which you can have multiple carriers competing with each other to attract and offer commercial services, which they are just not able to do.

While it is wonderful to be able to call Dr. Wolff to get an individual exception to the policy, which has been granted on numerous occasions, that, in my view, is an inappropriate national level policy for commercial development. We shouldn't have a bottleneck of individual permissions by the NSF. I see no reason for that whatsoever; that time has gone.

Mr. BOUCHER. Mr. Roberts.

Mr. ROBERTS. Very briefly, I would just like to say that the university policy position, as articulated in our policy statement, for over three years, has been that it is essential that information resources from both the public and private sector be accessible over the NREN and NSFNET. There are some examples of that already extant on an experimental basis.

And, secondly, part of the confusion we have here is that, although there has been a so-called interim NSFNET acceptable use policy for a long time, if I was a provider, I would say, well, when is this interim going to go away? Well, the interim finally—the statement got pried loose from the NSF lawyers just a couple of weeks ago, so I'm sure you want to take this up this afternoon.

But our position upon reading the statement, initial review of the statement, is that it permits, for purposes of research instruction, institutional access to commercial providers from any of the mid-level networks.

Mr. BOUCHER. That is the subcommittee's understanding.

Dr. Hood, a question for you. One of the recommendations that some have made is that instead of providing a subsidy as it is presently, that the public subsidy go directly to the regional networks and then allow the regional networks to simply use that subsidy as a means of purchasing network services from whatever source they care, whether that is NSFNET or one of the other backbones. You are speaking for the regionals today. What is your response to that suggestion? Are the regionals prepared to do that? Is that a workable approach?

Dr. HOOD. It certainly would require a transition phase where the options for regional connectivity for transcontinental services of transport could be examined, comparisons could be made so that the regional networks could make wise choices.

I think, too, it is important that we maintain a high level of stability in the national networking infrastructure. It is currently a three-tiered infrastructure with national backbone, transcontinental services, the regional layer, and the local area networks, and I would say that it is important that we don't perturb all layers simultaneously to a large extent, because we want to maintain the connectivity to the research and education community. I think it could be feasible and certainly worth investigating and studying.

If I might make one comment on the commercialization side—

Mr. BOUCHER. How soon do you think it might be feasible? before we leave that issue. Is it feasible now?

Dr. HOOD. To implement tomorrow or—

Mr. BOUCHER. Well, to implement this year.

Dr. HOOD. I think it would be difficult to implement on a time frame of this year; 18 to 24 months might be possible, depending on how much time, effort, and resources could be placed against the problem.

Mr. Boucher. What are the real barriers here? You talked about a transitional difficulty. Can you just briefly be more explicit about what that is?

Dr. Hood. Well, right now, all of the—many of the regional networks, the vast majority, perhaps not all, are connected to the NSFNET-sponsored backbone service, and so the transition to a competitive environment where there would be significant technical issues to address—now we have a single routing authority that manages the traffic; acts, if you will, as the general postmaster, making sure that the packets of information get to the appropriate addresses—would have to be revisited, and so I think it would take some technical investigation to make sure that on the scale of transition that is being proposed here or that you suggest as a possibility, to make sure that the network remains stable during that transition.

Mr. Boucher. Are the technical problems related to your connecting to other backbones? Is that what you are telling us? I mean it seems to me like it would be a fairly straightforward proposition to simply say to you, "Here is a handful of money; this will now be the public support for the current generation of network; use this money to buy backbone services in whatever form you wish, from NSF or someone else."

It is hard for me to understand how a great transitional difficulty is posed by that and whether and why, if we decide that is a matter of good public policy, it should take 18 to 24 months to move to it.

Dr. Hood. Well, let me explain the current situation in the national network connectivity provision arena. We currently have national network providers which are disconnected. A regional network today, if it wishes to attach to all of the research and educational entities and commercial entities that are on the network, has to procure multiple connections even today. There are disparate, balkanized islands of internet working within the United States, and so, although it might seem clear you could go out and buy services, it is not clear that you would buy the breadth of interconnectivity that would best advantage the research and education community.

I would like to see, and the mid-levels would like to see, that balkanization issue solved so that we could be sure if we bought from back home provider A or B or C, that all of the information and computing resources that are on the networks today are accessible to the entire community.

Mr. Boucher. All right. Let me move to another question, and then we will conclude with this panel, because we have been going now almost two hours.

One of the questions that some have raised, and we have heard some reference to it from this panel this morning, relates to the quality and the frequency of consultation by the NSF and its subcontractors, Merit and ANS, with the other network providers, with the service providers, and with the user community, and I would be interested in the response, perhaps starting with Mr.

Kapor and Mr. Schrader, to the quality and the frequency of that consultation and its adequacy.

Mr. Kapor.

Mr. **Kapor**. With your permission, since Mr. Schrader is the chief executive of a mid-level network, he might be—

Mr. **Boucher**. Mr. Schrader.

Mr. **Kapor**. —to start.

Mr. **Schrader**. I believe your question really is the level of consultation with us as opposed to within their own community. We certainly have open communications—that is, Steve Wolff and I can communicate by electronic mail, which is within the acceptable use guidelines, by his definition, and we do communicate frequently. He, of course, never asked me if they should form ANS; he never asked me if they should upgrade the T-3 and change the budget from four to 10 million; he never asked me a number of other questions which I outlined in detail in my written testimony.

I believe he—let's expand it to beyond Dr. Wolff, because he has a staff of very strong-willed people who are adamant about getting as much information as they can, and they do. They have gone out of their way to ask the community, and generally they ask FARNET. FARNET does not represent the entire U.S. community in networking, but it goes pretty far.

Mr. **Kapor**. All I want to add is a metaphor to this, which is that the net is—on the one hand has been shaped by a small number of very dedicated and hard-working individuals in Government and in the research community who continue to have a high band width of communication with each other.

At the same time, this virgin new territory of the net has been settled or homesteaded, if you will, by millions of individuals who don't even know that the NSF is involved, they just know they have an account, it may be through their university, it may be through an institution that is connected to PSI, and that—those homesteaders are not very well organized at this point; they are mostly interested in doing what they do, which is electronic mail, and file transfer, and playing games, and talking to their friends in Australia.

We need a process that somehow takes all of the settlers on the net, the users—who actually think they own it, by the way, although they may be a little bit confused about this—into the consultative process. That is a bit difficult, since they are not very organized, but it is a community with different norms, different values, and different interests than what you see represented here today, and without finding any fault whatsoever, I can honestly tell you that that community has not been part of the consultative process at all.

Now some might argue that they shouldn't be there to begin with and that they need to be evicted from cyberspace, although I wouldn't want to be the one to try to serve the eviction notice. No, I think that unintentionally what started as an experiment in computer networking has turned into a new kind of place, not a physical place but a metaphorical place of cyberspace. It has got people in it, they live a lot of their lives there, and the policy job should be to figure out how to make the U.S. portion of cyberspace the kind of place that we want it to be, and to do that is going to require substantially broadening how we think about all of these issues to figure out some way of including all of those settlers and homesteaders and early pioneers from cyberspace.

No answer to that, that I have today, but I want to raise that as a crucial issue for the future. If we keep the dialogue among the parties that it had been, I don't think any of us are going to be happy with the results.

Mr. **SCHRADER**. Could I add one more thing?

Mr. **BOUCHER**. Sure, Mr. Schrader.

Mr. **SCHRADER**. The actual concept of consultation is interesting, because in the free market the customers vote with their feet and with their wallets. In the fullness of time, as Mr. Packard said, it is only a question of time and when. Individuals and organizations will make their own decisions by buying from the provider of their choice. The sooner we get there the better is my opinion, because then there will be an open market and we will be able to compete with a free good, because it will no longer be free.

Mr. **BOUCHER**. Is it your opinion that the NSF has been reasonably responsive to the recommendations that you have made for changes in policy or modifications that would make your business more compatible with what the NSF is doing?

Mr. **SCHRADER**. They are always responsive to my phone calls and electronic mail. They certainly have not followed any of my concerns and responded to my explicit problems.

Mr. **BOUCHER**. Okay. I think I understand that answer.

Let me ask one other question. There are some other Federal agencies that support networking; among those, DOE, DARPA, NASA. To what extent is there appropriate collaboration among these Federal agencies with regard to the support of networking services today? And as we look toward the development of the NREN and another generation of networking services, is there any merit in considering consolidating Federal support for networking under perhaps a Government corporation or one single agency? Any thoughts on that? Who wants to volunteer?

Mr. Schrader.

Mr. **SCHRADER**. No. It is very difficult to mix the requirements of different mission agencies with the requirements of a civilian agency like NSF. We have tried. I have spent many hours, many days, many weeks and years with NASA, DARPA, DOE, and NSF, attempting to do just that, as has the NSFNET. It is, in my opinion, not possible to force those agencies to live within the same walls.

Mr. **BOUCHER**. All right.

Mr. Roberts.

Mr. **ROBERTS**. We have spoken about this, and I dealt with it in my prepared testimony. The Grand Challenge booklet put out by Dr. Bromley asserts that there will be a coherent and coordinated Federal networking effort for the NREN. There is under study material to put—to show us in the community what they mean by that. So we are pretty anxiously awaiting that, and the history of this isn't very good.

The agencies are under a lot of pressures, legitimate pressures, they are certainly under a lot of money pressures, and when they get into one of these interagency programs there is a lot of pulling and tugging about how much the center is going to dominate the parts. So we believe very strongly that it is absolutely essential for the success of the NREN for there to be a coherent and coordinated Federal participation in the overall effort.

Mr. Boucher. Does that suggest any particular structure at this point, or is it too early to be thinking about that?

Mr. Roberts. There are a whole lot of options here, and part of it bears on the subject matter of the legislation that you have introduced dealing with the national information infrastructure, because we simply can't discuss the NREN any longer without the fall-out, the second order fall-out, on that area. So I think that that is a subject on which there is going to be a lot of study, a lot of debate, a lot of opportunity for your committee to deal with later in the year.

Mr. Boucher. Would you like to offer an endorsement today for our infrastructure legislation?

Mr. Roberts. Yes, sir.

Mr. Boucher. Thank you.

Mr. Roberts. I thank that Dr. Rick Weingarten made the appropriate comment at a workshop we had in December on this subcommittee, and he said the problem we have here is that we have a whole lot of special interest views on the matter and we don't have a public interest view of what to do about the communications infrastructure and we badly need one.

Mr. Boucher. The goal of our legislation—well, of course it is to address some consumer problems in the provision of cable TV service. But beyond that, it is to give the telephone companies the financial incentive to deploy fiber-optics over what we call the last mile from their last switch into homes and businesses throughout the country, and the relationship of that effort to the NREN is that it will bring the services offered through the NREN directly to the user community; it will make those services available to virtually all Americans. So there certainly is a connection in that sense.

But sort of stopping short of that goal—and let's go from the switch backwards instead of from the switch forwards—should we have, do you think, a Government corporation that has responsibility for coordinating all the Federal efforts that are geared toward developing that gigabit speed network?

Mr. Roberts. Very quickly, we have made enormous progress on NSFNET and preparing for the NREN without new bureaucracy. The temper of the times argues, don't create new bureaucracy unless you are absolutely convinced that you have to have it, and I would say that is our position where things stand at the moment.

Mr. Boucher. That is fairly said.

Dr. Van Houweling, do you want to offer a comment?

Dr. Van Houweling. I have—I would first of all like to reinforce what Mr. Roberts has said, that a mechanism that focuses the agencies involved in the high-performance computing and communications effort on the actual grand challenges that are laid out in that legislation is badly needed, in my opinion, and I am pleased to know that there are a number of such mechanisms under discussion.

I do not believe that we will achieve our objectives there if we simply allow the money to be used for production activities within each of the mission agencies as opposed to having a common focus. How that should be done, I think, is something that I would very much like to see more information on.

The second thing I want to say is that, with regard to the national information infrastructure, I think that the existence of that legislation makes clear a position that I think has been underneath a lot of the discussion here today. The National Research and Education Network is a network that was, from the beginning, understood to be an experiment to try to drive the technology as rapidly and as quickly as possible for a community of users who, given their needs in research and education, needed the leading edge of networking technology and provided a test environment for that leading edge to actually be worked on. I think it has been marvelously successful. Its success, in fact, has led to the need for yet another effort now to make this capability available to commercial and private individuals throughout the society.

We need to be very careful that we don't lose the capability to push forward on the leading edge with research and higher education and moving down to experiments with education more broadly in order to make sure that we do the other thing, which is now badly needed, to provide a national information infrastructure.

Mr. BOUCHER. All right. Thank you very much.

Dr. Hood.

Dr. HOOD. Yes. Perhaps I stand the risk of supporting motherhood and apple pie, but FARNET certainly encourages a greater level of Federal agency cooperation and agrees with the statements that have been made by Dr. Van Houweling and Mr. Roberts.

I would also like to address your issue of the last mile question, because I think the regional networks can provide a service to the mission agencies in connecting their dispersed research communities located within Federal laboratory facilities, universities, colleges, and even some contracts within the private sector so that we avoid the cost of building redundant last mile infrastructures today, and the FARNET community stands willing to participate in that effort where there is a significant overlap of mission and where service provision can be—can meet the mission level standards, then we would like to offer the willingness to provide that support.

Mr. BOUCHER. Thank you very much.

I'm going to conclude this panel with those comments. This has been a very enlightening morning. I want to thank all the witnesses who have participated in this spirited discussion. We are only beginning our look at questions associated with the development of the NREN; I think this was an appropriate starting point; and the subcommittee's thanks to each of you for assisting us in that mission.

We will turn now to our second panel of witnesses, and these are representatives from the National Science Foundation: Dr. A. Nico Habermann, who is the assistant director for the Directorate for Computer and Information Science and Engineering; he is accompanied by Dr. Steven Wolff, who is the director of the Division of Networking and Communications Research and Infrastructure, also with the National Science Foundation.

Gentlemen, we welcome you here this morning. We will, without objection, make your prepared written statements a part of the record and would ask that you provide an oral summary of your statements, keeping that oral summary to five minutes, if you will, and perhaps using that occasion to respond to some of the key issues that have been raised here this morning with respect to the management of the NSFNET and looking forward to plans for development of the NREN.

Dr. Habermann, we will be pleased to begin with you.

STATEMENT OF A. NICO HABERMANN, ASSISTANT DIRECTOR, DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING, NATIONAL SCIENCE FOUNDATION, WASHINGTON, D.C., ACCOMPANIED BY STEPHEN S. WOLFF, DIRECTOR, DIVISION OF NETWORKING AND COMMUNICATIONS RESEARCH AND INFRASTRUCTURE

Dr. HABERMANN. Thank you very much, Mr. Chairman and committee members, for the opportunity to appear here and provide information about our exciting program in networking that NSF has great responsibility and interest in.

Since the first panel has already talked on so many topics, I will not just summarize my testimony which you already have in writing but want to highlight the intentions of NSF with the NREN program and then, indeed as you suggested, comment briefly to begin with on some of the remarks that the first panel has made.

The NREN program is part of the High-Performance Computing and Communications Initiative, as you mentioned at the beginning of your statement opening the session. It is one of the four components that NSF is involved in in this program that several agencies in the U.S. Government participate in.

The CISE Directorate, of which I am the assistant director for the National Science Foundation, has major responsibility to oversee the work in the HPCC program that NSF is involved in. The NREN program, one of the four components, has actually, by itself, two major components. The one is a component of research, of basic research into high-speed networking, often called the gigabit network research, and a component of developing surface network services. The latter part is the main part of discussion for today and includes the NSF network that we are talking about.

It is clear that the involvement of NSF is in two ways: in the first place, in providing the services of the NSF backbone which connects the regional networks, and in also supporting the research community in making use of the services. The networking program in NSF is a program that has actually a dual purpose; it has a purpose in itself, but it also has the purpose of developing this technology, and I want to comment right away on several remarks that the first panel has made and observe again that the network is—as it exists today, is an evolving technology and that NSF is involved in this technology to explore what the potentials are for the research and education community in the first place.

It is not like with telephony that the goals of the use of the network are well determined and that all that is needed is a change in the technology to achieve those goals. It is far more the case that the ways in which the networks is going to be used are still open for discussion and experimentation, and this is why it is important for NSF to be involved in stimulating the research and education community to find innovative ways of using the network capabilities.

Another point I want to make in favor of a continued involvement of the Government in these type of activities is, as mentioned, the user community is very much concerned about the potential balkanization of the networking infrastructure. There is a great interest in trying to make sure that individual regional nets have access not just to a small number of other regional nets but are able to communicate with practically everybody in the research and education community in the United States. At the same time, they want to also make sure that the communication is possible by well standardized protocols and ways of communications defined and controlled by the community at large.

At the same time, as I mentioned, we are very much in favor of trying to find out and explore what type of usage one wants to make of the network. We see in the future, for instance, if we reach the gigabit speeds that the user community will be interested in interactive remote access to computing facilities and to systems in general.

We also are very much concerned about the general access by the research and education community to participate in the grand challenges. We would be very much concerned if it were the case that only a few of our regional networks would be able to access and participate in the grand challenges, and we are very much in favor of making sure that also remote sites are able to participate in this research.

We think that the approach to the gigabit networks in the near future will bring us to a point where the distances will basically disappear. That is, it will be possible for people to do research over long distances and that in that sense discrimination between the poor and isolated places and the rich and well equipped places will gradually vanish.

The issue came up of the acceptable use policy. In that regard, I would like to give Dr. Steve Wolff, who is with me, a chance to comment on that in detail.

I want to mention one thing that also came up several times, and that is the possibility of allocating the money to the regional nets to participate and pay for their services on the backbone instead of having NSF pay for the backbone directly. One thing that came up from the user community is that they are very much concerned that that may put them in a very difficult position in the following sense. For the research community is, of course, applying for funds from various agencies and would have to include the fees that they pay for services in their proposals.

Then the question arises how this will be treated. As you well know, NSF tries to support as many researchers as possible, and as a side effect of that, it is often the case that we have to discuss the minimal budget that one can allocate to a particular proposal in order to do the research, and you will find that the researchers are of the opinion that in those negotiations the research itself will have priority over services like telephone and networking and other additional costs.

In addition to that, there is a tendency to try to decrease the overhead rates and decrease the overhead on the research contracts in general, and therefore you will find that there is very little sympathy by the institutions to include increasing costs in the overhead if not in the direct cost of research grants, and therefore the research community has expressed their concern that, if this is going to happen, that the access to the network for them will all of a sudden be an obstacle and that they therefore may lose that access which they now have in very general terms.

It is probably the right time for me to conclude my observations here and ask my colleague, Dr. Steve Wolff, to go into more technical testimony and also comment on several of the questions that were raised by the first panel.

Mr. BOUCHER. All right. Thank you, Dr. Habermann.

Dr. Wolff.

Dr. WOLFF. Thank you, Mr. Chairman. It's a pleasure to be here today and talk about my favorite subject. You have certainly given me plenty of scope.

I would like to begin by again departing from my written testimony and take my boss's suggestion and communicate to you that I share Mr. Kapor's frustration with acceptable use policies both in their application and in their enforcement, in their application because I would dearly love to be able to exchange electronic mail with my son in college in Minnesota, but I feel that is probably not acceptable; also, enforcement is a great problem, as Mr. Kapor pointed out.

Nevertheless, that acceptable use policy which has been being developed over a number of years with the advice of our external advisory committees and with the advice of NSF general counsel and has just generally been released, as Dr. Roberts said, represents, in the opinion of counsel, the most liberal possible interpretation of the use to which taxpayer funds can be put that is consistent with the NSF enabling legislation. Any freer use of those funds would be improper. If the Congress should choose to allow us to use networking funds for more general purposes, I, for one, would welcome that.

Mr. BOUCHER. Dr. Wolff, on that point, could you be a little bit more specific about the legislation to which you refer and its precise provisions that, in essence, require the acceptable use policy as I understand your position to be?

Dr. WOLFF. No, sir, I cannot be specific with either the name of the or the designation of the NSF enabling legislation nor its precise provisions.

Mr. BOUCHER. Is it in the NSF enabling legislation? Is that what you are referring to?

Dr. WOLFF. Yes. Yes, sir.

Mr. BOUCHER. Why don't you, if you don't mind, after this hearing is concluded, find that for us, the particular provision to which you refer, and call it to the staff's attention, because we are unaware of anything that is directly contained in the NSF enabling legislation that effectively would require this acceptable use policy, and we are interested in knowing your reasoning for coming forward with that statement.

Dr. **Wolff**. We would be happy to do that.

[The information follows:]

March 16, 1992

MEMORANDUM TO: Steven S. Wolff
Division Director, NCR

FROM: Miriam M. Leder
Assistant General Counsel

SUBJECT: NSFNET Backbone Services
Acceptable Use Policy

The National Science Foundation's appropriations act provides NSF with funds for carrying out the purposes of the National Science Foundation Act of 1950, as amended (the "Act"). NSF may use those funds for the support and development of the NSFNET if such use furthers an objective of the Act.

Section 11(b) of the Act authorizes NSF to "make such expenditures as may be necessary for administering the provisions of this Act." Section 3(a)(4) directs NSF to "foster and support the development and use of computer and other scientific and engineering methods and technologies, primarily for research and education in the sciences and engineering." These two provisions, taken together, justify NSF's support of the NSFNET, but only to the extent that it fosters and supports the development of the networks *primarily for research and education in the sciences and engineering.*

NSF developed its NSFNET Backbone Services acceptably use policy (AUP) to ensure that its funds are used in a manner consistent with statutory authority. The AUP may be more restrictive than is legally required, and it is currently being reviewed for possible revision. However, some form of acceptable use policy will continue to be necessary to ensure that NSF funds are used to further the objectives set forth in Section 3(a)(4) of the Act.

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Dr. **Wolff**. Secondly, I guess of the many things that I could comment on, perhaps I should talk about the access of the suppliers—network suppliers to our customers. First of all, we do, as has been mentioned earlier, allow PSI and the other commercial suppliers of network services unrestricted access to the NSFNET backbone services for research and education purposes.

We get in my office perhaps a dozen calls a week from all over the country—in some cases, all over the world—on, "How do I go about getting a connection to the internet?" My universal response to that is to read them a list of the commercial suppliers as well as the regional network that happens to serve their particular region of the country, if it is in this country, and tell them that they should go through their standard procurement practices and pick the supplier that they like.

We do not, on the NSFNET backbone services, retail those services to individual customers; NSFNET backbone services are available only to bulk suppliers of traffic, such as regional networks and supercomputer centers.

I think I have probably talked enough, and I will await your questions. Thank you.

[The prepared statement of Dr. Habermann and Dr. Wolff follows:]

Testimony of

Dr. A. Nico Habermann and Dr. Stephen S. Wolff

Committee on Science, Space and Technology

Subcommittee on Science

March 12, 1992

Part 1: Testimony of Dr. A. Nico Habermann

Mr. Chairman, thank you for the opportunity to appear before your committee today to provide information about the exciting program in networking supported by the National Science Foundation (NSF) and several other agencies of the U.S. government. I am privileged to serve as the Assistant Director of the NSF for the Computer and Information Science and Engineering Directorate, which has responsibility for broad national research, infrastructure and facilities programs in computer, communications, and information sciences and engineering. Included among my responsibilities is leadership of the overall NSF High Performance Computing and Communications(HPCC) Program with its important components in national Supercomputer Centers and the NSFNET, the subject of our discussion today.

In this latter respect, I am pleased to be accompanied by my colleague Dr. Stephen S. Wolff, Director of the Division of Networking & Communications Research & Infrastructure (NCRI). Dr. Wolff has provided leadership for this division since its inception and in this capacity has lead the creation and development of the NSFNET and the emerging NREN program. Before turning to Dr. Wolff, to elaborate on the NSFNET, I would very much like to place this activity in the larger context that it impacts.

Background

The President's High Performance Computing and Communications Program, which was announced on February 5, 1991, consists of four components, one of which is the National Research and Education Network (NREN). The NSFNET activity is part of the NREN component. The NREN is also a major subject of the High Performance Computing Act of 1991 (P.L. 102-194) that was signed by the President this past December. This Act, that your Committee was instrumental in drafting, provides important impetus to the presidential HPCC initiative.

Leadership and direction for the HPCC Program is provided by the Office of Science and Technology Policy, through the FCCSET Committee on Physical, Mathematical, and Engineering Sciences (PMES). The High Performance Computing, Communications, and Information Technology (HPCCIT) subcommittee is chartered under the PMES and is composed of an executive council and four task groups to coordinate science and engineering computing, computer research and development, Federal networking and communications, and education. Since October 1991, I have served as the Co-Chairman of this Networking activity.

As described in the Supplement to the President's FY 1993 Budget, "Grand Challenges 1993: High Performance Computing and Communications", NSF is designated as the coordinating agency for the NREN program. As the NREN title indicates, to quote from the Grand Challenges report, "The NREN program is both a goal of the HPCC Program and a key enabling technology for success in the other components. The NREN is the future realization of an interconnected gigabit computer network system supporting HPCC." If we are successful in deploying this technology for the research and education community, then aside from supporting current science and technology Grand Challenge Applications that are important to federal mission agencies, it will broadly influence communications technology development. However, it is important to bear in mind, that the government program, as its name implies, primarily supports computer and communications networking for research and education, not general purpose usage. Nonetheless, the NREN component incorporates important testbeds and research for new communications technologies.

The NREN component is dedicated to promoting communications among researchers, educators, and students in the U.S. The NREN activities contribute directly to the goals of the High Performance Computing and Communications Program in three ways:

1) by extending U.S. technological leadership in computer communications;

2) by enhancing the dissemination and application of computer and communications technologies to enable advances on applications such as, Grand Challenges; and

3) by demonstrating innovative new means of communication to spur gains in U.S. productivity.

In order to achieve these goals, the NREN program consists of two sub-components: one that supports the development and enhancement of network backbone services, which serves the purpose of connecting a large number of regional research and education networks - the Interagency Interim NREN; and a second sub-component, which supports basic and experimental research in the design of large-scale, high-speed networks for future use (gigabit networks R&D).

The first NREN sub-component, developing connections between existing and growing regional networks, includes three network backbones supported by NSF, DOE and NASA. The backbone currently supported by NSF is the NSFNET, which connects a large number of regional networks at a variety of educational and research institutions throughout the U.S. The NSFNET backbone, all of whose services are competitively procured from the private sector, provides a networking superstructure that enables scientists and educators to communicate across the boundaries of their regional networks. The second NREN sub-component, supporting networking research, includes a collection of five gigabit testbed networks, connecting experimental sites across the entire nation.

At each step of the development of the NSF NREN program, we must ask ourselves why the government should continue to be involved with the private sector in developing computer network infrastructure to support the research and education community. Although the private sector plays an increasingly important role, there are indeed cogent reasons why the government should stay involved in important aspects of a host of activities in network development and research. In order to put further discussion regarding NSF's role in networking in perspective, it seems proper to list here the main reasons, as we see them, for NSF's continued involvement in support of technology development and deployment.

- The proper and effective use of very high speed computer networks, and the connection between networks will require innovative research across various disciplines and technologies that government, industry, and academia working together are uniquely capable of providing.

- It is certain that the capabilities of networks can be increased at least a hundred-fold to support a mode of interaction we can only dream of today. (Imagine, for example, the impact of a hundred-fold increase in both aircraft speed and passenger capacity on travel, military, and on airports, etc!). To meet these challenges, industrial and academic R&D, coordinated and focused by the Federal Government, will concentrate on the advanced generic technologies required to realize a very high speed network.

- Since there is practically no limit to further development of networking technology, the research and education community should be stimulated to find and explore innovative ways of communicating with each other and with growing information sources. At this time, we think that the development will lead to the use of networks for remote, interactive, real-time computing. However, experience with the ARPANET, designed in the mid-seventies, has shown that the outcome may well be both broader and richer than our original expectations.

- Networks help broaden the participation for the entire country by providing equal access to advanced computer facilities, such as, the supercomputer centers, for remote and relatively isolated parts of the country and similarly help increase the involvement of minorities and under-represented groups in the research and education enterprise. This enables all scientists and students to more fully participate in leading-edge research and education opportunities that otherwise might not be affordable.

- My final point supporting NSF involvement in this technology development and deployment relates to the need to encourage all educational institutions, including K-12, to explore the networking capabilities that allow them to access and use the tools that researchers develop and utilize in the work on the Grand Challenges. This can lead to more excitement in education and may stimulate more students to enter science and engineering.

NSF welcomes the opportunity to work with the private sector on these and all other aspects of networking to the benefit of our science and education community in the interest of the Nation's future. And now with your permission, I would like to turn to my colleague Dr. Stephen Wolff to provide an overview of the current state of NSF's networking program and summarize the management and development plan and associated policy issues.

Part 2: Testimony of Dr. Stephen S. Wolff

Mr. Chairman, thank you for this opportunity to appear today before this committee to discuss the NSFNET and related activities.

There are three parts to my testimony. I will discuss first the current state of the NSFNET Backbone project, including its relationships to other networks that actually, or potentially connect to it, and also the management controls the NSF has in place with its awardee, Merit, Inc. Second, I shall report on the progress we have made in implementing the Project Development Plan for continuation and enhancement of NSFNET Backbone services which was approved by the National Science Board in November last. Finally, I shall briefly discuss the relationships between the NSFNET and NREN programs, including the interagency management structure now evolving for the NREN as an Administration program with a legislative authority.

Current State, Other Networks, and Management Controls

a. Current State

The five year cooperative agreement between the Foundation and Merit, Inc. for management and operation of the NSFNET Backbone was signed in November, 1987, after a five month period of competitive announcement and merit review of proposals. Merit, and its partners IBM and MCI, put in place a 13-node, 1.5 mb/s (million-bits-per-second), or T1, network in a very short time. The new Backbone began to carry traffic in August, 1988. In that month, traffic doubled over the July figure for the original Backbone network that the new one supplanted.

Since August, 1988, traffic on the Backbone has increased more than fifty-fold, from 200 million to 11 billion packets per month. This increase in traffic has been accommodated by hundreds of minor engineering improvements to the network and two major upgrades. The first upgrade increased the number of links in the network from 14 to 19. This increased the robustness of the Backbone by multiply connecting all 13 nodes, and it increased capacity as well. The second upgrade increased the number of Backbone nodes from 13 to 16 (the three new nodes were competitively selected), and raised the transmission speed from T1 to T3 (1.5 to 45 mb/s).

All the engineering improvements and both major upgrades were clearly foreseen and discussed in Merit's original farsighted proposal to the NSF. Such are the economies of scale in telecommunications that the upgrades to accommodate a fifty-fold traffic increase have been achieved with only a doubling in cost to the Foundation - from the original $14 Million over five years to the present five-year project cost of $28 Million.

The NSFNET Backbone is the linchpin of the overall NSFNET project, which includes establishment of and assistance to regional networks that deliver Backbone service to every state in the union. Other significant measures of the size and success of the NSFNET project include:

- More than 600 of the 3-to-4,000 two-year and four-year colleges and universities in the nation are interconnected, including all the schools in the top two categories of the Carnegie Foundation classification of major research universities.
- Several hundred high schools are also connected, but the exact number is difficult to determine since regional networks have widely leveraged NSF funds to connect the smaller institutions without NSF's direct involvement.
- Many industrial research organizations and commercial establishments that support the nation's scholarly enterprise are connected; indeed, the so-called ".COM" domain is the fastest growing segment of the network.
- The NSFNET Backbone is the default infrastructure for the nation's research and education community. It carries, for example, ten times the traffic of the Department of Energy's ESnet Backbone which interconnects many NSFNET client sites with national laboratories and other DoE facilities.
- By selecting a proven set of open communication protocols ("TCP/IP") and mandating their use in the NSFNET, the Foundation catalyzed an entire industry in which there are now upwards of a half dozen US manufacturers. US made packet switches and gateways dominate the world market, and a T1 packet switch can now be bought for well under $10,000. (By contrast, before NSFNET, the most widely used network packet switch operated at a speed of only 56,000 bits per second and was priced at $120,000. A further effect has been to substantially increase the connectedness of the scientific community as several other large networks, e.g., MFENET, the forerunner to ESnet, and European HEPNET, the European High Energy Physics network, have switched in recent years from their own proprietary communication protocols to those (TCP/IP) compatible with the NSFNET.)
- NSFNET's selection of TCP/IP has led to it becoming the most widely used set of open communication protocols in the world. Procedures for transporting these protocols over emerging telecommunications services, such as the Switched Multi-megabit Data Services (SMDS) and Frame Relay have recently advanced to Draft Standard status. Because of this, NSFNET and the Internet will be able to benefit from whatever economies may be available from using the new offerings of the telecommunications carriers.
- Scientists and educators on NSFNET can now collaborate over the network with their peers in 39 countries on 7 continents, and every month brings new requests for connection to the US network of which the NSFNET and its Backbone is the principal component.

b. Other Networks

Another measure of the success and influence of the NSFNET project has been the emergence and rapid growth of private sector offerors of TCP/IP network services. These include: UUNET Technologies, which indeed predated the NSFNET, but has grown rapidly in recent years; Performance Systems International (PSI), a spinoff from the NSF funded regional network NYSERNET; Advanced Networks and Systems (ANS), who provide NSFNET Backbone Services under contract to Merit; US Sprint; InfoNet, a multinational

TCP/IP provider; and CERFnet, which functions as a regional network in Southern California. Several of these private providers have formed a cooperative for interchanging traffic known as the Commercial Internet Exchange, or CIX, of which Mitch Kapor is Chair.

The NSFNET Backbone is limited to uses compatible with the NSF enabling legislation, as amended. There is an "NSFNET Backbone Services Acceptable Use Policy" (the "AUP", a copy of which is attached to this testimony) which was developed in consultation with an NSF Advisory Committee and the NSF General Counsel and expresses this limitation. The general principle is worth stating, "NSFNET Backbone services are provided to support open research and education in and among U.S. research and instructional institutions, plus research arms of for-profit firms when engaged in open scholarly communication and research"

By contrast, the private providers, have no such limitations. Although much of the traffic on their networks need not conform to the AUP, *it is NSF policy to allow the private providers to use NSFNET Backbone services to exchange AUP-conformant traffic between their customers and NSFNET clients*. However, the NSFNET Backbone may NOT be used by the private providers as a "transit network" - i.e., to interconnect their fee paying customers.

In this traffic sharing environment, ANS occupies an especially sensitive position since NSF indirectly, through Merit, is one of its customers. Accordingly, NSF has made special arrangements with Merit to monitor the quality of service afforded to NSFNET and to ensure that the traffic of ANS' private customers does not adversely impact NSFNET Backbone services.

c. Management Controls

The NSF participates with Merit, IBM, MCI, the State of Michigan, and (since its formation in 1990) ANS in three series of regular meetings which collectively form the primary means of oversight and control. There is a biweekly "Partner Conference Call" which functions at the tactical level, a monthly "Engineering Meeting" for technical desiderata, and a quarterly Executive Committee meeting which considers strategic issues. During the transition from the T1 Backbone to T3, the Executive Committee also scheduled weekly conference calls. As provided for in the Cooperative Agreement with Merit, NSF convened a blue ribbon review panel of academic and industry experts and conducted a two day long review of Merit's Backbone performance at the eighteen month anniversary. The panel rated Merit's performance "excellent".

The Project Development Plan

In November, 1991, the National Science Board (NSB) approved a plan for continuation and enhancement of NSFNET Backbone Services beyond the expiration of the current cooperative agreement with Merit in November, 1992. The NSB also approved an extension of the agreement for a period not to exceed eighteen months in order to allow new providers to be competitively selected and to provide for an orderly transition. A copy of the Plan is attached to this testimony.

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The Plan was developed after more than a year of external consultation. During this year of consulting the external community, NSF supported two workshops at the Kennedy School of Government at Harvard - one in March 1990 and the second in November, 1990. These workshops involved university networkers, economists, specialists in public policy (especially telecommunications policy), telecommunications carriers, and others. NSF's sister Federal agencies involved in the NREN were consulted at a meeting convened for this purpose in July, 1991, since the NSFNET Backbone is the most heavily used Backbone network among the several agency networks that are developing the NREN. The Foundation sponsored a workshop in August, 1991, by the Federation of American Research Networks (FARNET), a trade association that was inaugurated in 1987 to act as the voice of the regional networks, the "users" of Backbone services. The workshop was also attended by all the private providers of Backbone services, as well as telephone company representatives.

In addition, the Networking & Communications Research & Infrastructure Division Advisory Committee was consulted at its meeting in November 1991. That Committee includes leading researchers in the communications and networking field, private network providers, and telephone company representatives. Moreover, NCRI staff participated at public meetings of the networking community, such as meetings of the Internet Engineering Task Force (sponsored by industry), Net'90 and Net'91 (sponsored by the academic and user community), and others. The Plan has a schedule that includes release of a draft Solicitation in February 1992, a three month period for public comment, followed by release of the final solicitation in May.

Owing to unexpected delays in releasing a separate but related solicitation, and the technical complexity of the proposed new NSFNET Backbone architecture, it has not been possible to adhere to the original schedule. The other solicitation has been released, NSF's engineering experts have been consulted, and it now appears the draft solicitation will be ready at the end of March, so the schedule has slipped by about eight weeks. We believe there is still adequate time to accomplish the solicitation-review-award-transition process within the eighteen month extension authorized by the NSB. The technology permits a planned, gradual, and orderly transition of traffic from one provider's facilities to another's.

The transition, now in progress, of moving traffic from the T1 Backbone to T3 provides practical experience for the future. The Plan provides for a degree of continuing competition among two or more TCP/IP service providers in furnishing NSFNET Backbone Services. There will however be no significant changes in the rules for access to NSFNET Backbone Services by commercial service providers. The Acceptable Use Policy, developed in consultation with the NCRI Division Advisory Committee and the NSF General Counsel represents, in the opinion of Counsel, the most liberal interpretation possible under the NSF enabling legislation, as amended. This current policy allows access to commercial services for the support of open scholarly research and education under the General AUP Principle stated above.

NSF believes the next award will clarify the issues in free and open competition for the provision of Backbone services, and will conclude with at least two fully qualified and experienced providers of bulk services. It is likely, therefore, that NSFNET Backbone funds may - after the end of the next award (i.e., by FY 1996) - be distributed competitively to those organizations (currently the regional networks) who require Backbone services so that they may procure them competitively on the open market and free of Federal intervention. NSF had wished to employ this model at the expiration of the Merit award, but was advised at the FARNET workshop that the regional networks (the "users") were unprepared for that degree of operational complexity on their part. Moreover, sister Federal agencies felt in addition that such a procedure would, at the current state of technology, result in serious routing instability in the network, prejudicial to the accomplishment of their missions, since they depend heavily on the NSFNET to reach many of their grantees and contractors. NSF will continue working with the regional networks and the sister Federal agencies to overcome these obstacles.

In a separate, but closely related activity, the NSF has just released a competitive solicitation for Network Information and Registration Services. These are services which have traditionally been provided for the worldwide Internet by Network Information Centers (NICs) associated with the major US Backbone networks (i.e., ARPANET, NSFNET, ESnet, and the NASA Science Internet) as well as by Centers operated by NSF regional networks, by campus network organizations, and by the private TCP/IP network providers. The principal NIC, however, was for many years operated by SRI International under contract to the Defense Communications Agency (now the Defense Information Systems Agency, DISA). In a recent re-competition held by DISA, SRI lost the contract to another firm. DISA is funding the new contractor, GSI, to serve only the Defense Data Network; accordingly, NSF is funding GSI on a month-to-month basis for service to the rest of the Internet (including, of course, its largest component, the NSFNET) until NSF's recently released solicitation can result in a new Network Information Center. During the month-to-month funding, NSF is closely monitoring GSI's operation. It is interesting to note that the commercial users of the Internet, many of whom are clients of the private TCP/IP providers, form the largest single user class of GSI's services.

Relation to NREN

Finally, I would like to turn briefly to the relation of the NSFNET to the overall NREN program that is part of the HPCC Program described earlier by Dr. Habermann.
The planning process for the HPCC Program is coordinated by the HPCCIT Subcommittee. This subcommittee meets regularly to coordinate agencies' HPCC programs through information exchange, common development of interagency initiatives, and review of individual agency HPCC proposals and budgets. This process provides for agency participation through agency proposal development and review, budget crosscut development and review, and interagency program coordination. Agency programs are reviewed against a set of evaluation criteria for merit, contribution, readiness, linkages to industry, and other factors.

During 1990, in order to provide for broader and more inclusive coordination of research and education communities, the NSF, as part of its HPCCIT network task group activities, created the Federal Networking Council (FNC) and initiated the creation of an FNC Advisory Committee (FNCAC) as an NSF advisory committee.

The FNC consists of representatives from Federal agencies that have requirements for operating and using networking facilities, mainly in support of research and education, and for advancing the evolution of the Federal portion of the Internet. Membership lists of the FNC and FNCAC are attached to this testimony. Achieving the goals of the NREN will require close coordination of the NSFNET, NASA Science Internet (NSI) and Energy Sciences Network (ESNet) programs to meet the expectations of scientists working on the Grand Challenge problems. At the same time, however, the NSFNET program will vigorously pursue wider NREN goals of developing the technologies that will enable access by libraries, use for lifelong education, and connection to health care systems, etc. The NSF will continue to involve the private sector to the greatest extent possible for meeting the goals of public policy in this arena in the most cost-effective and technically responsive way. NSF is participating with the other agencies in the FNC in the drafting of the NREN report required of the Office of Science and Technology Policy by the High Performance Computing Act of 1991 (P.L. 102-194.)

Attachments to

Testimony of

Dr. A. Nico Habermann and Dr. Stephen S. Wolff

Committee on Science, Space and Technology

Subcommittee on Science

March 12, 1992

NSFNET Backbone Services Acceptable Use policy

Project Development Plan

Federal Networking Council Membership List

Federal Networking Advisory Council Membership List

THE NSFNET BACKBONE SERVICES ACCEPTABLE USE POLICY

GENERAL PRINCIPLE:

(1) NSFNET Backbone services are provided to support open research and education in and among US research and instructional institutions, plus research arms of for-profit firms when engaged in open scholarly communication and research. Use for other purposes is not acceptable.

SPECIFICALLY ACCEPTABLE USES:

(2) Communication with foreign researchers and educators in connection with research or instruction, as long as any network that the foreign user employs for such communication provides reciprocal access to US researchers and educators.

(3) Communication and exchange for professional development, to maintain currency, or to debate issues in a field or subfield of knowledge.

(4) Use for disciplinary-society, university-association, government-advisory, or standards activities related to the user's research and instructional activities.

(5) Use in applying for or administering grants or contracts for research or instruction, but not for other fundraising or public relations activities.

(6) Any other administrative communications or activities in direct support of research and instruction.

(7) Announcements of new products or services for use in research or instruction, but not advertising of any kind.

(8) Any traffic originating from a network of another member agency of the Federal Networking Council if the traffic meets the acceptable use policy of that agency.

(9) Communication incidental to otherwise acceptable use, except for illegal or specifically unacceptable use.

UNACCEPTABLE USES:

(10) Use for for-profit activities (consulting for pay, sales or administration of campus stores, sale of tickets to sports events, and so on), or use by for-profit institutions unless covered by the General Principle or as a specifically acceptable use.

(11) Extensive use for private or personal business.

This statement applies to use of the the NSFNET Backbone only. NSF expects that connecting networks will formulate their own use policies. The NSF Division of Networking and Communications Research and Infrastructure will resolve any questions about this Policy or its interpretation.

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PROJECT DEVELOPMENT PLAN

Continuation and Enhancement of NSFNET Backbone Services

Summary

This Plan fosters growth and competition in the business of networking while maintaining the stability and reliability of a service that has become a valuable tool of the US research and education enterprise. It also provides for enhancement of the Backbone by allowing vendors to offer services based on emerging digital offerings of the telecommunications industry. The duration of the Project is three years and involves two concurrent solicitations, under one of which multiple awards are contemplated. Based on costs of the current Backbone, the three-year cost of the Project is estimated to be $18 million.

Background

The current NSFNET Backbone interconnects sixteen nodes and is operated by Merit, Inc. under a competitively awarded five year cooperative agreement with the NSF. Connected to each of the sixteen Backbone nodes are one or more "resource centers" such as a supercomputer center or a national laboratory, or regional networks (e.g., SURANET, CERFNET) which aggregate network traffic from scholars and scholarly resources at academic, industrial, and government campuses. Regional networks are autonomous entities, supported by their campus clients and, in many cases, by a subsidy from the NSF. Although they are, collectively, in a state of rapid change and growth in clientele and traffic, their existence and support is not at present an issue. The NSFNET Backbone is the only government-sponsored source of non-mission-restricted trans-national connectivity for the scholarly community; this request to the National Science Board concerns continuation of this connectivity after the cooperative agreement with Merit ends.

Issues

1. Emergence of competition and maintenance of stability

When the competition for management and operation of the current NSFNET Backbone was conducted in 1987, the ARPANET operator (BBN) was the only organization with experience in operating a nationwide network using the (now standard) Transmission Control Protocol/Internet Protocol (TCP/IP). Indeed, there was widespread skepticism that the winner of the competition, Merit, and its joint study partners IBM and MCI, would be successful in the NSFNET Backbone enterprise since none of the three had any

TCP/IP experience.

Subsequent events proved these doubts unwarranted, and Merit's success, by triggering rapid and sustained growth in number of users and in usage, catalysed the emergence of new private enterprises offering national-scale TCP/IP networking. Within the networking community there is broad consensus that, in "recompeting the Backbone", the NSF must build on and sustain this new diversity of competitive TCP/IP offerors.

Hundreds of thousands of researchers, students, and other scholars - including many engaged in "mission-critical activities" sponsored by agencies such as NASA and the Department of Energy - depend on the NSFNET Backbone and system of regional networks for uninterrupted, reliable service every day. This community's natural concern for stability in the provision of national networking services presents, to a degree, a countervailing force to the pressure for competition and multiple providers discussed above.

The challenge to the Foundation is to construct a continuation of Backbone services so that the two worthy goals, stability and competition, are both fostered to the greatest extent possible.

2. Fair competition

In September, 1990 (the third year of the cooperative agreement between Merit and the NSF), Merit subcontracted the management and operation of the NSFNET Backbone to a new not-for-profit concern capitalized by IBM and MCI. There is substantial agreement in the networking community that, while providing for continued Backbone services, the NSF should assure both that the incumbent is not favored and that there is an equitable opportunity for other firms to participate in the long-haul TCP/IP networking business.

3. Timing

The complexity of these issues has been compounded by their timing: a credibly competitive TCP/IP networking arena has only arisen within the past two years, and became an urgent issue with the September 1990 IBM-MCI spinoff.

In the past year, NSF has sponsored and participated in several workshops and meetings, and has consulted affected communities, networking experts, and representatives of other government agency networks in a variety of other forums. Only now is this process leading to an emerging community consensus on the future of the Backbone.

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In August, 1991, the Federation of American Research Networks (FARNET), a trade association of regional networks that use the NSFNET Backbone for trans-national connectivity, organized a workshop under NSF sponsorship to consider the future provision of Backbone services. Their report[1] affirms the need for continued strong NSF support for top-level Backbone services and recommends a recompetition during Fiscal Year 1992 with multiple awardees.

In the early Fall of 1991, the Networking and Telecommunications Task Force (NTTF) of EDUCOM which represents academic campus networks and computer centers met and issued a report[2] on the same subject. They say *"Uncertainty prevails because of the expiration... It is imperative that... NSF take immediate steps to clarify their intentions with respect to the stability of backbone services"*, and later strongly recommend *"A new, competitively awarded cooperative agreement"* for continued Backbone services.

The Division Advisory Committee (DAC) for Networking and Communications Research and Infrastructure met on November 4 and 5, 1991, and considered all currently known options for the post-1992 Backbone. They overwhelmingly preferred a recompetition with multiple awardees.

4. NREN involvement

Further complexity has been introduced by the five-year High Performance Computing and Communications (HPCC) initiative in the President's fiscal year 1992 budget, which gives NSF the responsibility for implementing the National Research and Education Network (NREN) and coordinating the participation of other federal agency networks. Since the NSFNET Backbone will be a central feature of the NREN, the management of acquiring its services post 1992 is complicated by the need to treat the NSFNET as part of a total national information infrastructure for the support of research and education, and by the necessity of multiple agency coordination.

In order to help meet its NREN responsibilities, the Division of Networking and Communications Research and Infrastructure engaged an independent engineering group (the NSF NREN Engineering Group, or NEG) to advise on technical matters of the implementation. Their preliminary architectural report is completed, and will inform the proposed solicitations.

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[1] "Recommendations to the National Science Foundation from the Board of FARNET, Inc. Regarding Inter-midlevel Connectivity after the Expiration of the Current NSFNET Backbone Agreement", FARNET, Inc., Waltham, MA, 11/91

[2] "EDUCOM Networking and Telecommunications Task Force Statement on the Structure of the National Research and Education Network", EDUCOM, Washington, DC, 10/91

Plan Overview

An analysis of the tasks performed by Merit and its subcontractor Advanced Networks and Systems (ANS) under the existing cooperative agreement suggests a resolution of the stability/competition dilemma. In addition to furnishing and operating telecommunication circuits and packet switches, Merit staff serve in a higher-order technical capacity known as the "Internet routing authority" (the tactical and technical maintenance of the database that drives the dynamic packet routing algorithms of the worldwide Internet). Although Merit now carries out both functions, the NEG have pointed out that it is *not* necessary they be vested in the same organization; the DAC observed that in the case of multiple awardees for *connectivity*, separation of the routing authority function is desirable in order not to give one connectivity awardee a tactical advantage over the other(s). Since the provision of circuits and switches is highly competitive, but the key to network stability lies in careful and conservative operation of the routing authority, the NSF will address the issue of stability vs. competition post-1992 by issuing *two* solicitations: one (for connectivity) crafted to promote competition, and a second (for the routing authority) designed to maintain continuity and stability. These solicitations will be developed with community consultation and advice, and the resulting proposed awards brought to the National Science Board for approval.

Over the past five or more years, the telecommunications industry has been developing a new set of standards for digital communication; these standards extend to speeds of 2.4 gigabits per second, and their adoption and implementation are likely to fundamentally alter the ways in which computer communication is done. Vendors have begun implementing the standards in switching equipment, and early examples are being installed by the carriers. The awards to be made under this Plan will be structured as Cooperative Agreements so that these new technologies, such as the Switched Multimegabit Data Stream, (SMDS), Frame Relay, and others can be experimentally incorporated.

There are several ways to foster competition in Internet connectivity. NSF staff intend to follow the recommendation of their advisors by specifying, in the competition for Backbone connectivity services, that "more than one award will be made." Since the major telecommunication carriers have begun to move aggressively into the Internet arena, effective and sustained competition is likely.

Schedule

3 Feb 92	draft solicitations for connectivity and for routing authority prepared
4 May 92	solicitations finalized, mailed out
20 May 92	public information meeting for proposers
3 Aug 92	proposals due
10 Sep 92	merit review panels meet
Oct 92	as required: site visits, reconvene panel
Feb 92	present recommendations to National Science Board
Apr 93	awards made

Cost Projections

Activity	Year 1 ($m)	Year 2 ($m)	Year 3 ($m)
CONNECTIVITY	$6.0	$5.0	$4.0
ROUTING AUTHORITY	1.2	0.9	0.9

These projections anticipate a decreasing schedule of costs for high-bandwidth services from the telecommunications carriers, and allow for equipment acquisition by the Routing Authority in its first year of operation.

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Stephen Wolff, National Science Foundation, Executive Director

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- Joe B. Wyatt, Vanderbilt University

Mr. **Boucher**. Well, we thank you both very much for those opening statements. I do have some questions.

You are in the process now of formulating a recompetition for management of the NSFNET. Tell me a little bit about the schedule for that, addressing specifically when you intend to have an RFP available for the public, when you expect to award the new contracts, when you expect those contracts to become effective, and address, if you would also, why we may have to have, in the words of your agency, an extension of up to 18 months of the current agreement, given the fact that the current five-year agreement expires this fall. Why the delay? Why has it taken that long in order to get this recompetition off the boards?

Dr. Wolff.

Dr. **Wolff**. The schedule that we had approved by the National Science Board is on page five of the project development plan which accompanies my written testimony. As you will no doubt notice, we have slipped that schedule already. That schedule calls for a draft solicitation rather than R—we don't do RFP's at the Foundation—a draft solicitation to be made available for public comment on February 3. We think now we will probably have something available for public comment by the end of this month, so we will have slipped perhaps seven or eight weeks.

We built into the schedule a period of about three months for public comment, and we will publish this solicitation as widely as we know how and make it available for all parties to comment on. We hope then to finalize this solicitation now and mail it out by the end of May. We will have a public information meeting for potential providers, potential bidders, and expect to have proposals due some time in August.

As you can see from the schedule, we expect to make an award by April of next year, and I think it is still just barely possible to make that schedule.

Mr. **Boucher**. Now, once the award is made just about a year from now, how long will it be before that awardee actually commences network operation?

Dr. **Wolff**. Clearly, it depends on the amount of infrastructure that the awardees, because there will be, by the plan, at least two—the amount of infrastructure that they have already in place and the engineering details that are specified in the solicitation.

We have allowed—by asking for 18 months, we have allowed for up to a year of the winners getting facilities in place and to engage in an orderly transition from the old provision to the new providers. We believe that that is a prudent amount of time to allow. In the case of the current award, Merit, IBM, and MCI took seven months—seven to eight months to go from scratch to a fully operating network, and that was, in technical opinion, a remarkable accomplishment.

We have seen in the transition from the T-1 to T-3 service that with the amount of traffic now on the backbone and the transition to a much more advanced technology, that the transition is a very ticklish and delicate business indeed. We think it is prudent to allow a year in the open plan for that.

Mr. **Boucher**. Do you intend to take into account in making an award the amount of infrastructure that the various bidders already have in place, or will that be irrelevant to the process?

Dr. **Wolff**. That is irrelevant to the process.

Mr. **Boucher**. Tell me how you intend to package the various RFP's. As I understand it, the routing authority will be one award and then you will separate awards for switches and circuits. Did I basically get that in the right order?

Dr. **Wolff**. That is exactly right.

Mr. **Boucher**. So you will have three awards or two awards?

Dr. **Wolff**. There will be three awards—two solicitations and three awards.

Mr. **Boucher**. Now, as you are putting this recompetition together, are you planning any changes in the acceptable use policy? Will that be a part of the recompetition? We heard some of the witnesses here earlier today say that some of the competitive problems that they perceive exist at the present time could be successfully addressed in this recompetition. Is it your intent to take that into account?

Dr. **Wolff**. I think that there is some misunderstanding of the acceptable use. In fact, I know there is. There is no prohibition against the distribution of for-fee commercial services over the network for research and education purposes, and indeed many commercial information providers—Westlog, Dialog, Medata Central, Cosmic, the Well—distribute their services over the NSFNET backbone for research and education purposes. It is not necessary for these providers to go to ANS. They can—because we allow unrestricted access to the NSFNET backbone for research and education, a provider may go to any supplier of services and be ensured that they will have connectivity to the research and education community which we serve.

Mr. **Boucher**. One of the recommendations that has been made—and this is not a recommendation of this subcommittee, at least certainly not at this time, but just for purposes of discussion I would like your opinion. What would be the effect if you were to say, as a part of your recompetition, that the companies that are your successful awardees for routing authority on the one hand, circuits and switches on the other, cannot have any role in offering a commercial service that is carried on the NSF network as a way to ensure absolute fair treatment? I'm not saying that is the only way to ensure fair treatment, but it may be one. What is your response to that potential? and have you given any thought to that as you structure this recompetition?

Dr. **Wolff**. In terms of the providers of lines and switches and new technology are concerned, I have not considered that. We will certainly take that under consideration. I believe, off the cuff, that—no, I don't think I would like to make a comment on that off the cuff.

Mr. **Boucher**. All right.

[Laughter.]

Mr. **Boucher**. Maybe you wouldn't.

Let me just say that the real question here is: What would be the advantages and disadvantages of that kind of approach? and I'm particularly concerned about what that would do to enabling some very qualified bidders to take part in this solicitation. We obviously want qualified people, the best companies, to bid, and would you be ruling out some of the best potential operators of these various aspects of the network if we had such a requirement?

If you would like to cogitate a bit and supply an answer later, that would be fine.

Dr. Habermann.

Dr. **Habermann**. I wanted to make a general comment to how we deal with questions of that nature. Of course, we haven't thought of everything, but in general, you know, it is actually not just up to us to decide such questions, but what we typically do in NSF, of course, is to listen to the community, and we would definitely not take a decision like that ourselves, but we would at least go to our advisory committees and to our National Science Board to come with a proposal and have a discussion on those issues.

Mr. **Boucher**. Okay. And we will have a discussion with you as well as time goes on.

Let's talk a little bit about the acceptable use policy and the proposals that some have made for having that abandoned. One of the questions that has been raised is enforcement. What level of confidence do you have that the acceptable use policy enforced today, that those who are offering commercial services over the NSF backbone are, in fact, paying for the access they get?

Dr. **Habermann**. I think that that depends very much on the nature of the network. The network is an education and research network, and it is a utility used by the academic community, and there are certain rules and almost unwritten rules in the academic community that apply in this case.

It is indeed the case that the regional nets do check this through their deans' offices, through their community regulations, and how one should use these, and it is in general the case that indeed the control is retroactive; it is actually not proactive. It is not that we impose very strict rules and in advance; we give people very loose ideas of what the restrictions amount to; and it is not until we notice, until certain abuses are noticed, that action is taken.

Mr. **Boucher**. Are you getting any evidence that there is abuse?

Dr. **Habermann**. There is occasional abuse, and I think that that is—you can't tell, of course—right? With a retroactive system, you can't tell whether there is abuse that we haven't discovered.

Mr. **Boucher**. Dr. Van Houweling suggested that it is 1 percent or less of all the commercial traffic. Do you agree with that estimate?

Dr. **Habermann**. I have an experience of 12 years as a department head and dean at a very large user of networking in general and also one of the institutions that has contributed greatly to develop networking, and in—I would certainly agree to that point of view. In my time of 12 years, I can think of only very minor violations.

Mr. **Boucher**. So the evidence you are getting suggests no greater abuse—meaning that commercial traffic doesn't pay for access—than 1 percent or less of the total commercial traffic.

Dr. **Habermann**. I would agree with that point of view, yes.

Mr. **Boucher**. Dr. Wolff, do you have any comment on that? You can just say you agree if that is the case.

Dr. **Wolff**. I think that we—I know that we always act on cases of abuse that are brought to our attention. These happen recently very, very seldom, because it is retroactive, because we don't police the network, because we don't look over anybody's shoulder and read their mail, and, of course, it is impossible to tell what—if it is a conspiracy to misuse the network, it will go undiscovered. But when abuses are noticed, we do enforce the policy.

Mr. **Boucher**. I guess the more relevant question is, how good is your mechanism for having this information come to you? and it sounds like it is basically an honor system.

Dr. **Wolff**. Yes.

Dr. **Habermann**. That is correct.

Mr. **Boucher**. All right.

Tell me, if you would, your view of the advantages and disadvantages of simply abandoning the acceptable use policy and treating commercial and noncommercial traffic the same way on the NSF network, either having a charge for all of it or having no charge for any of it.

Dr. **Habermann**. I think that that would indeed go with that, what you just stated, right? It has to go with either no charge at all or charge for everything, and I can't see that that—I mean that that is absolutely also related to the question of whether the NSF would pay directly for the backbone services or that the community pays indirectly.

Mr. **Boucher**. That phrases the question; I'm looking for an answer.

Dr. **Wolff**. I think that the positive side of allowing unrestricted access is that it would allow the network to exploit the very real economies of scale that have been referred to before, and the possibility of doing that was, of course, as Dr. Van Houweling mentioned, the reason behind the ANS and ANS CORE.

The—I wouldn't say it is a down side—one of the consequences would almost certainly be an enormous increase in traffic. There would have to be a way of accommodating that increased traffic, and that could be—if that were funded with public funds, we would have to be assured that that was a permissible use of public funds to support commercial activity over the network.

Mr. **Boucher**. And I gather you believe that there is some statutory question as to whether you have that authority.

Dr. **Wolff**. Within existing legislation, yes, sir, that is what I believe.

Mr. **Boucher**. Well, it is an interesting question. If you go to an all-charge basis so that you are charging both for the commercial and the noncommercial traffic, then there is a very real risk that some of the less well heeled users will not be able to afford the access, and that would then call into play the necessity of providing some kind of public subsidy directly to those users or, as some have suggested, to the regional networks that, in turn, could support their entry.

If you go to a totally free system, then the question becomes how do you, as the NSF, continue to manage this network? I mean your role essentially ends, I would suppose, if it is all for free.

Dr. **Wolff**. We do at present subsidize the less advantaged schools. The charge for network access made by most regional networks for a school to connect takes into account the cost of running the regional network. It does not contain a component for use of the backbone, because the backbone is subsidized from above. It is provided to the regional network as a free good.

But even so, there are schools who are unable to afford even the $20,000 or $30,000 it takes to connect to a regional network. Those we subsidize in response to proposals which they send us for a period of two years.

Mr. BOUCHER. So you are already providing some subsidy directly to users in order to finance the charge made by the regional network to connect them up.

Dr. WOLFF. Being careful to understand that in this, user—the definition of "user" depends on context. In this case, "user" is a campus. For the purpose of the NSFNET backbone, the user is a regional network.

Mr. BOUCHER. Correct.

Well, one of the witnesses—and I can't recall which one—on the first panel—maybe Mr. Roberts—suggested that if the subsidy generally were provided to users, not necessarily to regional networks but to actual users, campuses and the like, in order to accommodate a change in the acceptable use policy, where you would have a charge for everyone entering the network, commercial traffic and noncommercial traffic alike, that an unworkable system would be created and that it would not administratively be possible to accommodate that. Do you think it would be, in view of the fact that you have some experience in doing precisely that already?

Dr. WOLFF. I believe that we—with the staff now on hand, we would not be able to administer a program that distributed all network funds to all current users of regional network and backbone services.

Dr. HABERMANN. May I add one little point to this? We are also very much interested in evolving the technology, and in this regard I think if the users pay directly there is a chance that the technology would stabilize at the current state of affairs, and we are very much interested in encouraging people, say, even to do outrageous things with the network, to try out and, in the future, for instance, to have the ability to do interactive remote access to systems, to computer systems, and that kind of usage is right now not possible, and we want to encourage people and not put an inhibition there in having them pay for the services that are now still very expensive.

Dr. Wolff just mentioned, for instance, the connection that we allow, say, high schools and others to connect up to the net. Say, about five, six years ago, just before the NSFNET was started, the ones who connected to the DARPA net at the time would pay typically between $100,000 and $200,000 for having the connection made for them, and that cost has already come down to about $10,000 today, and so—but we want to encourage the work that will be cost effective in four or five years from now to be done today, and that is one reason why subsidy is indeed justified.

Dr. WOLFF. I would like to add something else, if I could.

Mr. BOUCHER. Dr. Wolff.

Dr. WOLFF. We do support the notion that the Government should get out of funding the network from the top, should get out of funding the suppliers and get into the business of funding the users. In this case, for the backbone services, the users are the regional networks.

During the better than year-long process of public consultation that we went through in designing the new solicitation, new project development plan, we talked to the regional networks at a meeting, a FARNET meeting, we talked to our fellow sister Federal agencies who are participants in the HPCC. I went into those meetings with the proposal that we fund the regional networks and let them buy backbone services.

Those of you, those of the audience, who were at the various meetings may remember the red and yellow stamp proposal, which was a scheme for ensuring that the submitted money would be used only for network services and not turned into graduate students or something else.

The response was, I found, surprising. The regional networks pretty much said that they did not feel that at their current state of development they were ready for that degree of freedom in their business operation. Furthermore, our sister Federal agencies were absolutely adamantly opposed. They feel that in order to accomplish their mission requirements under the HPCC that the network must be as close to a production, stable, unchanging environment as possible. They would prefer that we recompete the backbones—if we could not simply extend the contract the agreement with Merit in perpetuity, that we recompete the backbone under exactly the same terms as it was done before.

We have had to balance these two requirements, these two manifestly obvious requirements, of stability and the encouragement of competition and growth in network services. That is what we have tried to do in the project development plan, and that will be fleshed out more fully in the solicitation which will be available for public comment.

Mr. **Boucher**. That is very insightful.

We heard from Dr. Hood on the first panel that the regionals, given an appropriate amount of time, which he defined in months and not years, as I recall his response, could be prepared to move to that environment where they receive money from you as opposed to your subsidizing the operation of the NSFNET. Then they, in turn, could purchase services, connection to the NSFNET, for their clients.

So does that change your view of whether that is an appropriate approach? Will that—is that response, first of all, do you think, broadly reflective of what the regionals—regional networks now believe is possible?

Dr. **Wolff**. Yes, I think it is.

Mr. **Boucher**. Does that response change your view of the approach you should take with regard to the recompetition?

Dr. **Wolff**. No, it doesn't change the way the competition could be carried out. I do think that we will have to build into the solicitation a mechanism to allow that kind of freedom to occur during the life of the agreement or possibly make the agreement short enough, if we can feasibly do that, to accommodate that desire in a timely way.

Mr. BOUCHER. So it would be your intention then, broadly speaking, to conform essentially this recompetition to the goal of moving toward an environment where the regionals receive sums from the NSF in order to purchase services on the network.

Dr. WOLFF. Yes.

Mr. BOUCHER. Okay. Well, that is very interesting, and I think we have accomplished something in terms of our understanding of the issue with that response.

Let me just ask you about one other matter, and that relates to the other Federal agencies that support networking services. You mentioned that their preference was to simply recompete in the same configuration as the current contract, and I guess what you mean by that is that they would have preferred not to have an unbundling of these services but to simply have one awardee perform all the functions. Is that correct, that that would be their preference?

Dr. WOLFF. Yes.

Mr. BOUCHER. Why is that their preference? I mean it strikes me that what you are doing is very constructive in that you are now acknowledging that these various services do not have to be performed by a single manager, that they can be performed by different entities. Presumably by having this kind of competition you will get competitive bids and the best price for offering those services. Why would the other Federal agencies not understand that? What is their problem with that method of doing business?

Dr. WOLFF. I think there are two problems. One is the general proposition, if it ain't broke, don't fix it. The other has to do with technology. I think that one of the unique features of the partnership between industry, higher education, and Government from the current backbone has been the extraordinary amount of leverage of the public dollar. The—MCI and IBM have learned a lot about networking, and that presumably is why they have invested as much money as they have.

If we reduce the acquisition of backbone services to a mere commodity, there will be no incentive for industry to contribute to the operation. At NSF, it is a way of business. We believe in cost sharing, and we believe that we can best advance the technology if industry is allowed to participate in that, that advancement. By opening the backbone to unrestricted competition, our sister agencies and I believe at this point that we would not get the best possible technology, nor would we get what we get even now as cheaply as we get it.

Mr. BOUCHER. There is a perception that exists today that among the Federal R&D agencies that will have responsibility for helping to evolve the current network into the NREN, that only the NSF has a commitment to have broad-based access for the entire research and education community and that the other agencies may have something of a mission-specific goal in terms of their management of and use of the network. Is that a correct perception? and, if it is, is there something that we ought to be doing here in the Congress to encourage these other Federal agencies to have a little broader scope in terms of their notion of what the NREN ought to be?

Dr. Wolff.

Dr. WOLFF. There again, they believe that they will be held accountable if they cannot accomplish their missions, and if they cannot accomplish their missions because the network is broken they need somebody to yell at.

Because there are certain places in the Nation that are so critical to the other agencies' mission, their networks make direct connections to those sites—the National Laboratories, for example; NASA's research and space flight centers—and certain of their larger university and industrial contractors have direct connections to the Energy Sciences Network and to the NASA Science Internet.

But for the bulk of the traffic that goes to the scientific community, the other agencies rely on the system of NSFNET regional networks, the NSFNET backbone and the NSFNET regional networks. The NSFNET backbone, after all, carries 10 times the traffic of the other agencies' backbone; it is the largest, most pervasive network in the country. We reach campuses. When the other agencies want to reach the general scientific population, they must go through NSFNET. They have every right, I think, to be concerned about the stability of the service that they receive.

Mr. BOUCHER. Do you consult frequently with these other agencies about network management? Is there a regularized procedure for those consultations?

Dr. HABERMANN. Yes, there is. The management is all under the HPCC program, of course, and there is a committee that is called the HPCCIT committee that is overseeing that work, and subcommittees of that HPCCIT committee are responsible for overseeing networking and other activities. So there is regular consultation about the management of the various net center connections. There is also a Federal Networking Council that includes even other network interested parties and not just the agencies in which many of these issues are regularly discussed.

Mr. BOUCHER. As a part of the discussions that you are having with these other agencies, do you have the sense that they will share your enthusiasm for and commitment to broad-based access to the NREN once it is developed and put into place?

Dr. HABERMANN. I would say that as long as—as Dr. Wolff expressed, as long as they can be assured that their mission requirements can be fulfilled, then the answer is yes.

Mr. BOUCHER. Do you have a sense that their mission requirements can easily be accommodated consistently with having broad-based access for the research and education community?

Dr. HABERMANN. If that is in a structure that exists right now, I think that that is indeed the case.

Mr. BOUCHER. All right. You are not concerned that there will not be such limited capacity or availability of network services, that they will eventually see their mission as predominating over the needs to have broad-based access. You think the network can easily accommodate their needs as well as the research and education community?

Dr. HABERMANN. I would say yes, that is correct.

Mr. BOUCHER. Very good.

Well, gentlemen, we could go on for the whole afternoon; we are not going to do that; we are going to conclude at this time. I want to thank both of you for coming forth today, and I think you should be very proud of what you have accomplished. Even those who have some constructive criticism of the way that the network is presently managed acknowledge at the outset that you have done a terrific job in accomplishing the goal of this NSFNET, and its usership is enormously up, its cost to the users has come down, and you certainly have our congratulations for that excellent success. And we look forward to working with you as we continue our discussions about the evolution of that network into the National Research and Education Network.

Thank you very much for being with us today. This subcommittee stands adjourned.

Dr. WOLFF. Thank you, sir.

[Whereupon, at 12:45 p.m., the subcommittee was adjourned.]

SUBCOMMITTEE MARKUP OF H.R. 5344, AMENDMENT TO THE NSF ACT OF 1950

THURSDAY, JUNE 4, 1992

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
SUBCOMMITTEE ON SCIENCE,
Washington, D.C.

The subcommittee met, pursuant to notice, at 2:03 p.m. in room 2325, Rayburn House Office Building, Hon. Rick Boucher [chairman of the subcommittee] presiding.

Mr. BOUCHER. The subcommittee will come to order.

This afternoon the Subcommittee on Science is marking up a draft bill which the Chair is offering, dealing with the authority of the National Science Foundation to manage the NSFNet.

[Copy of the bill to be marked up follows:]

102D CONGRESS
2D SESSION

H. R. ___

IN THE HOUSE OF REPRESENTATIVES

Mr. BOUCHER introduced the following bill; which was referred to the Committee on ______________

A BILL

To authorize the National Science Foundation to foster and support the development and use of certain computer networks.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. ADMINISTRATIVE AMENDMENT.

Section 3 of the National Science Foundation Act of 1950 (42 U.S.C. 1862) is amended by adding at the end the following new subsection:

"(g) In carrying out subsection (a)(4), the Foundation is authorized to foster and support the development and use of computer networks which may be used substantially for purposes in addition to research and education in the sciences and engineering, if the additional uses will tend to increase the overall capabilities of the networks to support such research and education activities.".

Mr. **Boucher**. We will turn now to the legislation dealing with the National Science Foundation and the NSFNet. The draft bill that is before the subcommittee amends the NSF Act of 1950 by providing additional authority to the NSF in its management of the NSFNet. Specifically, the new authority would permit the NSF to repeal or modify, as it deems appropriate, its "acceptable use" policy by which it charges for the entry of commercial traffic onto the NSFNet backbone. The need for the amendment was highlighted during the subcommittee's March oversight hearing on management and operation of the NSFNet. Representatives of network users and network service providers, as well as witnesses from the NSF, all recommended the policy change which is enabled by this amendment. A more complete description of the amendment is included in the materials that have been placed before the members, and without objection, that more complete description of this amendment will also appear in the record.

[The prepared statement of Mr. Boucher, plus the full description of the amendment follow:]

STATEMENTBY THE
HONORABLE RICK BOUCHER (D-VA)
ON THE
AMENDMENT TO THE NSF ACT OF 1950

June 4, 1992

The draft bill before the Subcommittee amends the NSF Act of 1950 by providing additional authority to NSF for support of the development and use of computer networks. The Committee previously approved this amendment to the NSF Act, which was included in the Scientific and Technical Education Act of 1992, H.R. 2936. The Full Committee ordered H.R. 2936 reported on April 2nd.

The need for the amendment grew out of the Subcommittee's March oversight hearing on management and operation of the NSFNet. Representatives of network users and network service providers, as well as NSF, all recommended the policy change which is enabled by the amendment. A fuller description of the amendment is included in the materials before the Members.

Science Subcommittee Markup
June 4, 1992

Explanation of Draft Bill to Amend the NSF Act of 1950

On March 12, 1992, the Science Subcommittee held an oversight hearing to review NSF policies on management and operation of NSFNet, the national backbone computer network connecting more than 4000 institutions throughout the nation. NSFNet is the major federally supported network for research and educational purposes and is the forerunner of the National Research and Education Network (NREN) authorized by the High-Performance Computing Act of 1991 (P.L. 102-194).

The Subcommittee hearing identified a policy change that is needed to assist with the evolution of NSFNet toward the NREN. The purpose of the draft bill before the Subcommittee is to provide authority to NSF to change current access requirements to NSFNet which the agency claims are mandated by the NSF enabling statute.

At present, NSF provides NSFNet backbone services to support open research and education in and among U.S. research and instructional institutions, plus research arms of for-profit firms when engaged in open scholarly communication and research. Use for other purposes is not acceptable. This is referred to as the acceptable use policy. Electronic traffic conforming to the acceptable use policy may travel on NSFnet at no cost, while the cost of other traffic must be recovered.

Three principal arguments were advanced at the Subcommittee hearing to support changes to the acceptable use policy. First of all, the policy is essentially unenforceable since the contents of messages passing over the network are not monitored. Reliance must be placed on the honor system. Secondly, the policy tends to restrain growth of network traffic, which in turn prevents the cost per message to drop to the extent which would otherwise occur as traffic volume grows. Finally, some network users believe the policy has reduced commercial services available over the network due to uncertainty among network service providers about which kinds of traffic are allowed.

The draft bill would amend a provision of the NSF Act of 1950, which NSF has cited as requiring imposition of the current acceptable use policy. The amendment would authorize NSF to support the development and use of a computer network which carries a substantial volume of traffic not associated with research and education purposes. This new authority is subject to the condition that the presence of the non-conforming traffic would increase the overall capability of the network to support research and education activities.

This amendment was added to H.R. 2936, the Scientific and Technical Education Act of 1992, as reported by the Committee on March 18, 1992. NSF expressed support for the amendment at that time (attachment).

Mr. **Boucher**. I would like now to recognize the gentleman from California, Mr. Packard, for his comments on both of the measures which will be marked up today.

Mr. **Packard**. Thank you very much, Mr. Chairman.

This bill is intended to give NSF the flexibility to change the access requirements for its national computer network.

Testimony we received in the subcommittee hearing on NSFNet indicated that there was some confusion over the "acceptable use" policy of NSF. Furthermore, some witnesses testified that the policy had tended to restrain growth of network traffic.

I commend you, Mr. Chairman, for the efforts that the committee has made to seek a solution to the problems, and that we are now ready to bring the bill before the subcommittee. I understand, however, that there are still some problems that the Administration has concerning language as it is presently drafted, and Mr. Walker and I will work with the Administration to see if we can work out those difficulties before we mark it up at full committee.

So again, I commend the committee for bringing up this bill.

[The prepared statement of Mr. Packard follows:]

STATEMENT OF
THE HONORABLE RON PACKARD
SCIENCE SUBCOMMITTEE MARKUP
AMENDMENT TO THE NSF ACT OF 1950

2:00 P.M., 2325 RHOB
6-4-92

Thank you, Mr. Chairman:

- This bill is intended to give NSF the flexibility to change the access requirements for its national computer network.

- Testimony we received at the Subcommittee hearing on NSFNet indicated that there was some confusion over the acceptable use policy of the NSF. Furthermore, some witnesses testified that the policy has tended to restrain growth of network traffic.

- I commend the Chairman for his efforts to seek a solution to the problems that were brought out in the subcommittee hearing.

- Nonetheless, it is my understanding that the Administration may have some concerns about the language as it is presently drafted. Mr. Walker and I will be working with the Administration between now and full committee markup so that we can address any remaining concerns.

Mr. **Boucher**. The Chair thanks the gentleman. Let me assure the gentleman that we will be happy to work with him and Mr. Walker and representatives of the Administration, and take into account any suggestions that are made from those sources for modifications in the text of the bill.

I would note for the purposes of this discussion that by letter dated March 31, 1992, the Director of the National Science Foundation did inform Mr. Brown that the NSF fully supports the language as was contained in this amendment, offered within the context of another bill. We were acting, in drafting this measure and marking it up today, on the strength of that statement. Nevertheless, we will be very pleased to accept any recommendations or consider any recommendations that are forthcoming with respect to additional changes that should be made.

[The letter from Director, National Science Foundation follows:]

NATIONAL SCIENCE FOUNDATION
1800 G STREET, N.W.
WASHINGTON, D.C. 20550

nsf

OFFICE OF THE
DIRECTOR

RECEIVED
APR 01 1992
Committee on Science, Space
and Technology

March 31, 1992

Honorable George E. Brown, Jr.
Chairman
Committee on Science, Space, and Technology
U.S. House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

As the Committee prepares to mark up H. R. 2936, the Scientific and Technical Education Act of 1992, I would like to provide you with the views of the Foundation on this legislation.

Providing greater opportunities for scientific and technical education, at all levels, is a goal that has strong support at the National Science Foundation. The appropriate role for the Foundation is one of intellectual and substantive leadership. The Foundation is able to draw upon its position in the science, engineering, and mathematics education and research communities to provide leadership, developmental support, and intellectual resources to strengthen two-year college science, engineering, mathematics, and technology and the preparation of students graduating from high school.

NSF agrees with the Committee's desire to support programs that will lead to a more technologically capable workforce. Immediate attention needs to be drawn to the issues which most dramatically affect the quality of instruction in science, engineering, mathematics, and technology. Two-year colleges are ideally positioned to serve as catalysts for educational improvement and to address the national concern for scientific and technical literacy. The two-year college specifically provides for accessible, comprehensive services, and for quality undergraduate education, making it an effective agent for change.

NSF currently supports programs that focus on five key areas: Curricular reform and program improvement; professional development and renewal opportunities for faculty; assistance for the increasingly diverse and often academically unprepared student population; strategies that would expand linkages with elementary and secondary education as well as four-year colleges and universities; and partnerships among two-year colleges, private sector business, and industry.

NSF fully supports the findings in H.R. 2936 which states "...the improvement of our workforce's productivity and our international economic position depend upon the substantial upgrading and coordination of our educational efforts in science, mathematics, and technology, especially at the associate-degree level." We at NSF affirm the important role that two-year colleges play in the education of the nation's undergraduates, especially since community, junior, and technical colleges often serve as institutions of choice to minority and other underrepresented student populations.

While NSF agrees with the intent of this legislation, and we note that there have been some improvements in the bill since its introduction, our Organic Act already provides us with the necessary authority to carry out the objectives and programs within H.R. 2936. As such this bill adds nothing new to NSF's authority in this area and therefore the Administration opposes this bill.

I also wish to comment on the administrative amendment the House Science Subcommittee added during its mark up of this bill. This provision would modestly enhance the Foundation's authority in supporting the development and use of computer networks. We believe the provision would benefit the development of our networking activities and for that reason we are supportive of this particular provision and recommend it be included in legislation more acceptable to the Administration.

I hope you find these views useful as the Committee prepares to mark up the legislation.

Sincerely,

Walter E. Massey
Director

cc: Honorable Robert Walker

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Mr. **Boucher**. Does the gentleman from Indiana have opening remarks?

Mr. **Roemer**. Mr. Chairman, only to say that as a member of the Education Committee I see very, very closely every day, on both the Science and the Education Committee, the need for us to help at our associate degree level the engineering and scientific and technical base. I think this amendment to this draft bill does that. It will help us be more competitive. Having just visited two businesses over the weekend in my district that are working on these same problems in the workplace, this is something that is both practical for our workforce and also for our businesses. I move adoption.

Mr. **Boucher**. Okay. Well, the Chair thanks the gentleman for his remarks. We have several procedural matters to get to before we entertain the adoption of the amendment.

Mr. **Roemer**. Let me just say that I hope it is adopted, Mr. Chairman, and at the appropriate time, maybe I'll move adoption.

Mr. **Boucher**. Thank you very much, Mr. Roemer.

The Chair would ask unanimous consent that the draft bill be considered as the subcommittee markup vehicle and as original text for purpose of the markup.

[No response.]

Mr. **Boucher**. Hearing no objection, it is so ordered. Without objection, the draft bill will be considered as read and open for amendment at any point.

Does any member of the subcommittee seek recognition for purposes of offering an amendment?

[No response.]

Mr. **Boucher**. The Chair hears none.

The Chair would now recognize the gentleman from Indiana for purposes of a motion.

Mr. **Roemer**. Mr. Chairman, I move adoption of the draft bill.

Mr. **Boucher**. Is there discussion on the motion of the gentleman from Indiana?

[No response.]

Mr. **Boucher**. If not, the question occurs on the motion. Those in favor will say aye.

[Chorus of ayes.]

Mr. **Boucher**. Those opposed, no.

[No response.]

Mr. **Boucher**. The ayes have it and the motion is agreed to and the draft is adopted.

The Chair would now recognize Mr. Packard for purposes of offering a motion to report.

Mr. **Packard**. Mr. Chairman, I move that the subcommittee report the bill as presented, and further I move to instruct the staff to prepare the subcommittee report and make any necessary technical and conforming amendments, and that a clean bill, reflecting the subcommittee's action, be prepared by the Chairman for introduction into the House and further consideration by the full committee.

Mr. **Boucher**. Is there discussion on the motion of the gentleman from California?

[No response.]

Mr. **Boucher**. If not, the question occurs on the motion. Those in favor, say aye.

[Chorus of ayes.]

Mr. **Boucher**. Those opposed, no.

[No response.]

Mr. **Boucher**. The ayes have it and the motion to report is agreed to.

It is the Chair's intent that this bill will not be introduced until Monday, June 8th, and in the intervening period it is our hope that additional cosponsors can be obtained. So we would issue an invitation to members of the subcommittee to become cosponsors on this measure prior to the date of its introduction.

There being no further business to come before the subcommittee today, this session is adjourned.

[Whereupon, at 2:19 p.m., the subcommittee adjourned, to reconvene at the call of the Chair.]

FULL COMMITTEE MARKUP OF H.R. 5344, AMENDMENT TO THE NSF ACT OF 1950

WEDNESDAY, JUNE 10, 1992

U.S. House of Representatives,
Committee on Science, Space, and Technology,
Washington, D.C.

The committee met, pursuant to notice, at 10:23 a.m. in room 2318, Rayburn House Office Building, Hon. George E. Brown, Jr. [chairman of the committee] presiding.

The Chairman. Good morning. The committee will come to order.

The committee has before it to be marked up this morning, H.R. 5344, Amendment to the National Science Foundation Act of 1950. This is a relatively short and relatively non-controversial piece of legislation, and the Chair expects that it will be able to be taken care of expeditiously this morning.

[Copy of bill to be marked up follows:]

Rick Boucher

Rick Boucher, (D-VA)

102D CONGRESS
2D SESSION

H. R. 5344

IN THE HOUSE OF REPRESENTATIVES

Mr. Boucher (for himself, Mr. Brown, Mr. Kopetski, Mr. Valentine, Mr. Perkins, Mr. Nagle, Mr. Hayes, Mr. Browder, Mr. Roemer, and Mr. Bacchus) introduced the following bill; which was referred to the Committee on____________

A BILL

To authorize the National Science Foundation to foster and support the development and use of certain computer networks.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. ADMINISTRATIVE AMENDMENT.

Section 3 of the National Science Foundation Act of 1950 (42 U.S.C. 1862) is amended by adding at the end the following new subsection:

"(g) In carrying out subsection (a)(4), the Foundation is authorized to foster and support the development and use of computer networks which may be used substantially for purposes in addition to research and education in the sciences and engineering, if the additional uses will tend to increase the overall capabilities of the networks to support such research and education activities.".

Subcommittee on Science

Explanation of Draft Bill to Amend the NSF Act of 1950

On March 12, 1992, the Science Subcommittee held an oversight hearing to review NSF policies on management and operation of NSFNet, the national backbone computer network connecting more than 4000 institutions throughout the nation. NSFNet is the major federally supported network for research and educational purposes and is the forerunner of the National Research and Education Network (NREN) authorized by the High-Performance Computing Act of 1991 (P.L. 102-194).

The Subcommittee hearing identified a policy change that is needed to assist with the evolution of NSFNet toward the NREN. The purpose of the draft bill before the Subcommittee is to provide authority to NSF to change current access requirements to NSFNet which the agency claims are mandated by the NSF enabling statute.

At present, NSF provides NSFNet backbone services to support open research and education in and among U.S. research and instructional institutions, plus research arms of for-profit firms when engaged in open scholarly communication and research. Use for other purposes is not acceptable. This is referred to as the acceptable use policy. Electronic traffic conforming to the acceptable use policy may travel on NSFnet at no cost, while the cost of other traffic must be recovered.

Three principal arguments were advanced at the Subcommittee hearing to support changes to the acceptable use policy. First of all, the policy is essentially unenforceable since the contents of messages passing over the network are not monitored. Reliance must be placed on the honor system. Secondly, the policy tends to restrain growth of network traffic, which in turn prevents the cost per message to drop to the extent which would otherwise occur as traffic volume grows. Finally, some network users believe the policy has reduced commercial services available over the network due to uncertainty among network service providers about which kinds of traffic are allowed.

The draft bill would amend a provision of the NSF Act of 1950, which NSF has cited as requiring imposition of the current acceptable use policy. The amendment would authorize NSF to support the development and use of a computer network which carries a substantial volume of traffic not associated with research and education purposes. This new authority is subject to the condition that the presence of the non-conforming traffic would increase the overall capability of the network to support research and education activities.

This amendment was added to H.R. 2936, the Scientific and Technical Education Act of 1992, as reported by the Committee on April 2, 1992.

EXTENSION OF REMARKS

Rick Boucher

Rick Boucher (D-VA)

Introduction of a Bill to Authorize Activities by the National Science Foundation for Fostering and Supporting the Development and Use of Computer Networks

Mr. Speaker, the High-Performance Computing Act of 1991 (P.L.102-194) authorizes an interagency R&D program to accelerate development of computing and networking hardware and software, as well as to support the application of these new technologies for research and education purposes. A major component of this R&D initiative is the establishment of a National Research and Education Network (NREN). NREN is a high-speed computer network which will provide broad access to the research and education communities and will lead to a privatized infrastructure serving the needs off all sectors of society.

Under the interagency planning process for the High-Performance Computing program, the National Science Foundation (NSF) is the lead agency for implementing the NREN. NSF currently supports NSFNet, a national "backbone" computer network which provides connections to more than 4000 research and education institutions throughout the nation. Policies for management and operation of NSFNet are of particular importance since the NREN will evolve as an outgrowth of this current backbone network and current practices will strongly influence the evolution.

A recent oversight hearing on NSFNet by the Science Subcommittee identified a policy change that is needed to facilitate the development of the NREN. The purpose of the legislation I have introduced today is to provide authority to NSF to modify the current policy governing electronic traffic on NSFNet.

At present, NSF provides NSFNet backbone services to support open, non-proprietary research and education activities. This is referred to as the acceptable use policy. Electronic traffic conforming to the acceptable use policy may travel on NSFnet at no cost, while the cost of other traffic must be recovered.

Several arguments supporting changes to the acceptable use policy have been advanced. First of all, the policy is essentially unenforceable since the contents of messages passing over the network are not monitored. The policy tends to restrain growth of network traffic, which in turn prevents the cost per message to drop to the extent which would otherwise occur as traffic volume grows. Finally, some network users believe the policy has reduced commercial services available over the network due to unçertainty among network service providers about which kinds of traffic are allowed.

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The legislation I have introduced would amend the National Science Foundation Act of 1950, which NSF has cited as requiring imposition of the current acceptable use policy. The amendment authorizes NSF to support the development and use of computer networks which may carry a substantial volume of traffic that does not conform to the current acceptable use policy. This new authority is subject to the condition that the presence of the non-conforming traffic would increase the overall capability of the network to support research and education activities

Mr. Speaker, the proposed legislation will give NSF additional flexibility for developing, in concert with the private sector, a highly capable computer network for meeting critical national needs in support of research and education. The bill will advance progress toward the goals of the High-Performance Computing Act and will help provide the technology base for a modern information infrastructure for the nation

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We now proceed to call up H.R. 5344, amendments to the NSF Act of 1950. The Chair has a brief statement.

The purpose of the amendment is to provide additional flexibility to the National Science Foundation and its activities to support development of the National Research and Education Network referred to as NREN, and, of course, authorized by the Advanced Computer and Communication Act, signed by the President last year.

This amendment to the NSF Act of 1950 was also included as part of H.R. 2935, the Scientific and Technical Education Act of 1992, which was already reported by the committee on April 2nd.

Again, I want to congratulate Mr. Boucher, the Science Subcommittee chairman, for initiating this legislation.

The NREN is a key component for developing the technologies and operational experience essential for putting in place the future information infrastructure of the nation.

The bill will remove a potential impediment to maintaining progress toward that goal of the NREN.

Now, I would like again to recognize the ranking Republican member, Mr. Packard, for whatever statement he may wish to make at this point.

Mr. PACKARD. Thank you, Mr. Chairman.

I am sorry that Mr. Boucher is not here, because he has certainly taken a leadership role in this bill. In fact, it is his bill.

The intent of the bill is to provide flexibility to the National Science Foundation to change the access requirements for its national computer network.

I want to commend Mr. Boucher, the chairman of the Science Subcommittee, for his efforts to address a situation which was brought to our attention during the hearings on the NSFE NET.

Nevertheless, I must mention that the Administration does have some concerns about the language, and it is my hope that we can work through these concerns before the bill goes to the floor, but at this time I do support Mr. Boucher's bill and recommend that the committee pass it.

Thank you very much.

[The prepared statement of Mr. Boucher in support of H.R. 5344 follows:]

STATEMENT OF THE HON. RICK BOUCHER (D-VA) ON AMENDMENT TO THE NSF ACT OF 1950, H.R. 5344

June 10, 1992

On June 4, 1992, the Subcommittee on Science ordered reported the bill now before the Committee to amend the NSF Act of 1950. H.R 5344 provides additional flexibility to NSF in establishing policies for access to and use of computer networks supported by the Foundation.

Specifically, the legislation permits NSF to support networks which may carry a significant volume of commercial traffic. This new authority is subject to the condition that the overall capability of the network to support research and education activities be increased.

The need for the amendment grew out of the Subcommittee's March oversight hearing on management and operation of the NSFNet. Representatives of network users and network service providers, as well as NSF, all recommended the policy change on network use which is enabled by the amendment to the NSF Act of 1950. Advantages cited for relaxing current controls on the nature of electronic traffic on NSFNet included accelerated growth of the network, reduced costs to the government and increased network services for users.

The **Chairman**. Are there any other Members who would like to be recognized for an opening statement on this bill at the present time?

[No response.]

The **Chairman**. If not, then we will proceed to consider the text of the committee print as reported by the subcommittee as original text for purposes of markup and amendment, and it is considered as read and open for amendment at any point.

I might say that the Members all have in your packages a more extended report from the committee chairman, which you again may read at your leisure.

The Chair is unaware of any amendments to be offered to this bill, and—

Mr. **Packard**. If you would like, Mr. Chairman, I would be happy to make the motion then to report.

The **Chairman**. I would be most happy if the gentleman would do that.

Mr. **Packard**. Thank you.

I move that the committee report the bill, H.R. 5344, and to instruct the staff to prepare the legislative report and to make the technical and conforming amendments, that the chairman take all steps to bring the bill before the House for consideration.

The **Chairman**. You have heard the motion. Is there any discussion? If not, the Chair will put the question.

All those in favor, signify by saying aye.

[Chorus of ayes.]

The **Chairman**. Opposed, no.

[No response.]

The **Chairman**. The ayes have it, and the measure is approved.

Is there any further business to come before the committee?

[No response.]

If not, the Chair wishes to thank the members for their cooperation, their diligence, their good looks, anything else they need to be complimented for on the record.

[The prepared statement of Mr. Packard follows:]

STATEMENT OF
THE HONORABLE RON PACKARD
FULL COMMITTEE MARKUP
10:00 A.M., 2318 RHOB
JUNE 10, 1992

HR5344 Amendment to the NSF Act of 1950

* Mr. Chairman, the intent of this bill is to provide flexibility to the National Science Foundation to change the access requirements for its national computer network.

* I commend the Chairman of the Science Subcommittee for his efforts to address a situation which was brought to our attention during a hearing on the NSFnet.

* Nevertheless, the Administration has some concerns about the language and it is my hope that we can work through these concerns before the bill goes to the floor.

[Whereupon, at 11:06 a.m., the committee adjourned, to reconvene at the call of the Chair.]

APPENDIX

March 9, 1992

The Honorable Frederick Boucher, Chairman
U.S. House of Representatives Subcommittee on Science
Suite 2319, Rayburn House Office Building
Washington, D. C. 20515-6301

Dear Chairman Boucher:

This letter is to provide comment to the U.S. House Science Subcommittee in preparation for its March 12 hearing on the National Science Foundation Network. I am the President of CICNet, a 501 C(3) corporation created in 1988 to build a network which would provide its founding members with connectivity to the National Science Foundation Network. CICNet's mission includes the provision of internet services to clients from throughout its seven-state region of operations (Iowa, Minnesota, Wisconsin, Illinois, Michigan, Indiana, Ohio) and today CICNet carries traffic for over 100 organizations representing both the for-profit and not-for-profit sectors of the region.

The CICNet Board of Directors consists of representatives of its founding members, which are the universities of Chicago, Illinois, Illinois at Chicago, Indiana. Iowa, Michigan, Michigan State, Minnesota, Northwestern, Ohio State, and Wisconsin. The Argonne National Laboratories, the University of Notre Dame, the Pennsylvania State University, and Purdue University also send representatives as invited guests of the Board. Collectively these universities represent over 30,000 faculty and 500,000 undergraduate students. On any given year they account for approximately 15% of the nation's annual output of Ph.D's and between 12% and 15% (over $1.2 Billion) of the nation's funded research activities. Needless to say, the interest by CICNet's community in the evolution of a successful national research and education network is more than casual.

In order to accomplish its mission, CICNet is structured to run as a business. It finds itself constantly aware of the nature and activities of its competition, the costs of providing services to its members, the evolution of underlying technologies necessary for it to succeed, and a full range of other elements critical to its success in today's marketplace. It is safe to say that my perspective is that of a president of a small business whose employees go to work every morning excited about working in an environment inherent in any such enterprise, but with that strong and always prevalent inner sense that success depends upon our ability to provide our clients with more value than the competition, at less cost, and in ways which can be sustained over time.

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Let me begin with a few observations. First, the impact of the National Science Foundation Network (NSFNET) has been nothing less than profound. The sometimes astonishing success of the NSFNET has created an environment in which, for the first time in my memory, there is an incredible amount of energy from constituencies within both the public and private sectors. These range from large industries to one-person organizations and from secondary education to our largest universities and laboratories, all focused on a single effort -- the evolution of a national research and education network. This effort goes well beyond a focus on research and education. The work currently underway is one of the key components in our nation's drive to regain its competitive posture in the global marketplace, and we need to do everything in our power to maintain the momentum.

In this process we have spawned a highly competitive environment, and to a large extent that environment exists because of the National Science Foundation's ongoing efforts towards developing a privatized network. Privatization of any publicly funded activity is at best a difficult and uncertain process, complete with risk and inequities. In virtually every case the actual privatization of an activity will almost never go as smoothly as either the idea's original architects or the participants in the process would have desired.

The current efforts to develop a privately operated national networking infrastructure, however, is rapidly becoming a true success story. The number of companies involved in the provision of internet products and services is growing annually. There are now at least thirty regional networks, few of which existed five years ago; nationally focused companies such as ANS, PSI, AlterNet, and Infonet, most of which did not exist five years ago; and recent announcements by carriers such as Bell Atlantic, Ameritech, USWest, Sprint, WILTEL, MCI and AT&T which will clearly result in a full range of internet services years before such services would have been available in the absence of the leadership provided by the National Science Foundation. The number of companies currently in the industry, the number who have clearly signalled an intent to enter within a year, and the many, many other options currently available in the marketplace make for a very open and competitive playing field. And of course, as a provider of internet products and services, CICNet works every day to compete directly with some of these companies, partner with others, and diffuse the effects of the remainder.

Like all companies, CICNet also continually evaluates its options for procuring the "raw material" that it needs to provide its services. Outsourcing is one of those options in the networking business, and CICNet may be the only network to actually enter into procurement cycles, not once, but twice during the past three years. In both cases the company had a range of choices. The company considered proposals from AT&T/Ohio State, Ameritech/University of Illinois, the Minnesota Supercomputer Center, Infonet, General Atomics/CERFnet, Merit Inc., and Bolt, Beranek, and Newman when it elected to outsource network engineering, operations and management to AT&T in early 1990. Six months ago, when CICNet went back to the marketplace with the thought of outsourcing the network itself and/or some alternative combination of network engineering, operations and management, there were again seven options and, had it elected to do so, it could have solicited many more proposals. The competition for CICNet's business was very real, sometimes intense, and three of the competitors submitted proposals which were actually priced less than that of ANS, the vendor which ultimately won the contract for network operations and management.

I should note that the fact that CICNet felt it necessary to enter into what is a difficult and complex procurement cycle twice in such a short period of time is a direct result of the rapid evolution of the industry, a constantly changing business environment, and the existence of clear opportunities to take advantage of the emergence of new technologies, offerings, and competitors. There is little doubt in my mind that the future will provide additional opportunities at an even greater pace.

As I think about the business environment that I have outlined above and ponder what I would advise as national policy from this point, the key issues seem to revolve around two relatively clearly defined questions. The first is how to ensure that we continue to support the nation's current requirements for a production-level high performance network while simultaneously deploying network capacity at the gigabit level and beyond; the second is how to ensure that this goal is accomplished in an environment designed to continue to encourage private investment. I would argue that if Congress develops adequate policy in answer to those two questions then it will have also defined the answers to a number of related questions which, while important, are not central to the issue. Two examples of these "related questions" are: how to ensure that the network is well-managed and how to guarantee that the current open and competitive environment continues into the future.

It is critical that the nation have a research program focused on continually pushing the envelope of high performance production networking. From my perspective the current scheme is working very well. Of course there are difficulties. It is not possible to conduct any such program without them, but I strongly believe that some of the alternatives that I have heard about, such as leaving the evolution of advanced communications technologies to the vagaries of the private sector or to a federal agency which might not consider research in high performance communications as central to its mission, will lead to its demise. I would hope that there is little disagreement by responsible individuals on this point, and that I need not argue the it further. Simply put: the National Science Foundation should continue to manage a well-funded program focused on advancing the state of the art in high performance communications.

The question of developing policy which continues to encourage an increasing amount of private investment in any publicly-funded activity is a difficult one, and the problem is exacerbated in the telecommunications industry because of the built-in interdependencies among the providers. Since the market for production-level high performance networking has grown to the point where it is appropriate to view access to such resources as a commodity, possibly to be provided and managed by whatever forces evolve in a natural fashion, I advise caution because of the potential for national policy to be irrelevant by the time that it is defined and implemented. The line between competition and chaos can be very thin indeed, and I know of no individual who would argue that chaos is an acceptable option.

National policy should focus on the development of resources not currently available from the private sector combined with programs which would further encourage the full integration of the power of networking technologies into the complete spectrum of pedagogic activities conducted by our nation's systems of secondary and post-secondary education. Such policy would continue the current trends toward both technology transfer to the private-sector and the increasing amount of private sector investment in communications technologies and services, both of which are essential ingredients in our overall efforts towards global competitiveness.

I appreciate the opportunity to comment on these issues. I stand ready to provide additional information, should the need arise, and, of course, will continue to follow with great interest the results of the hearings that you have scheduled for March 12.

Sincerely,

E M Staman

E. Michael Staman
President

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